

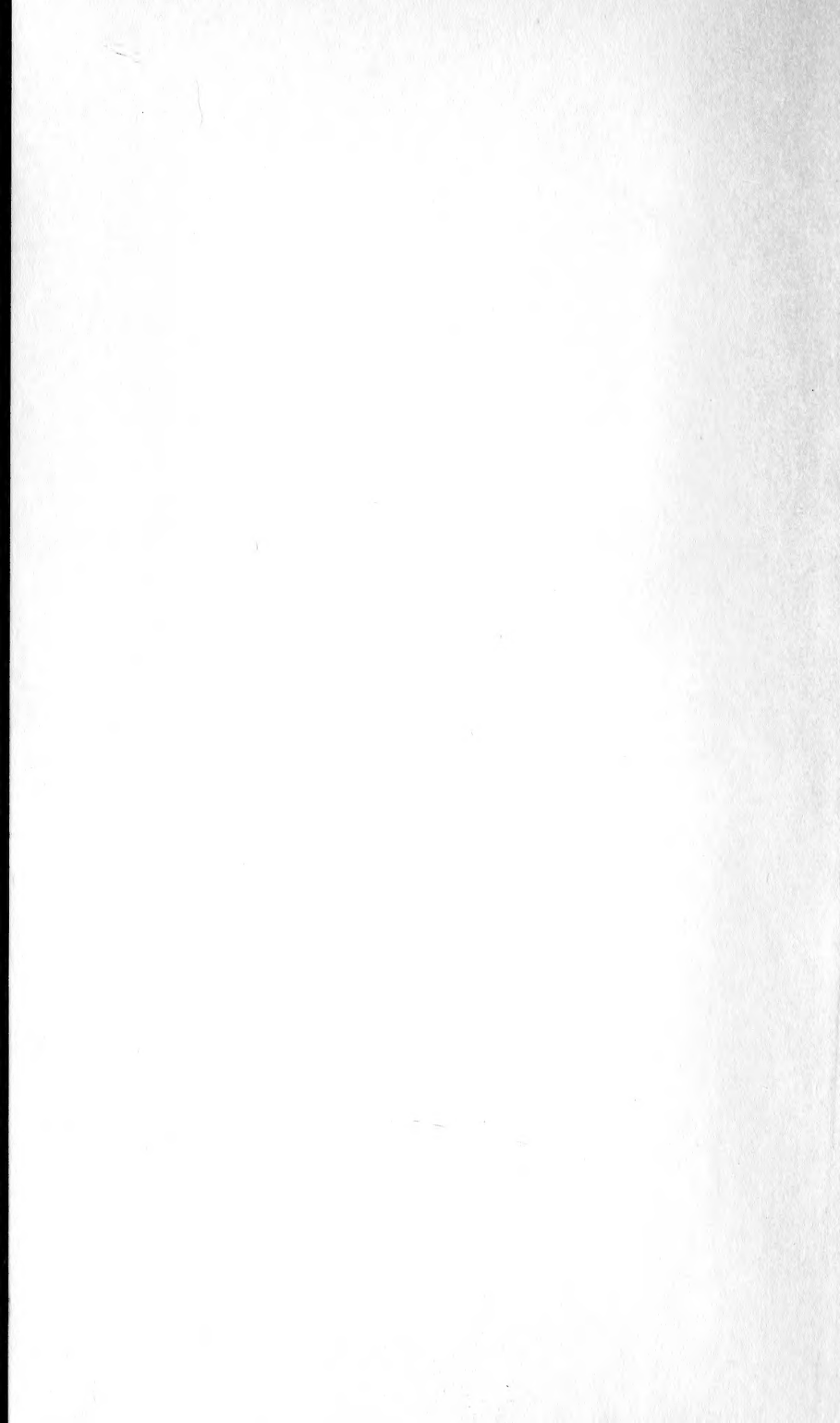
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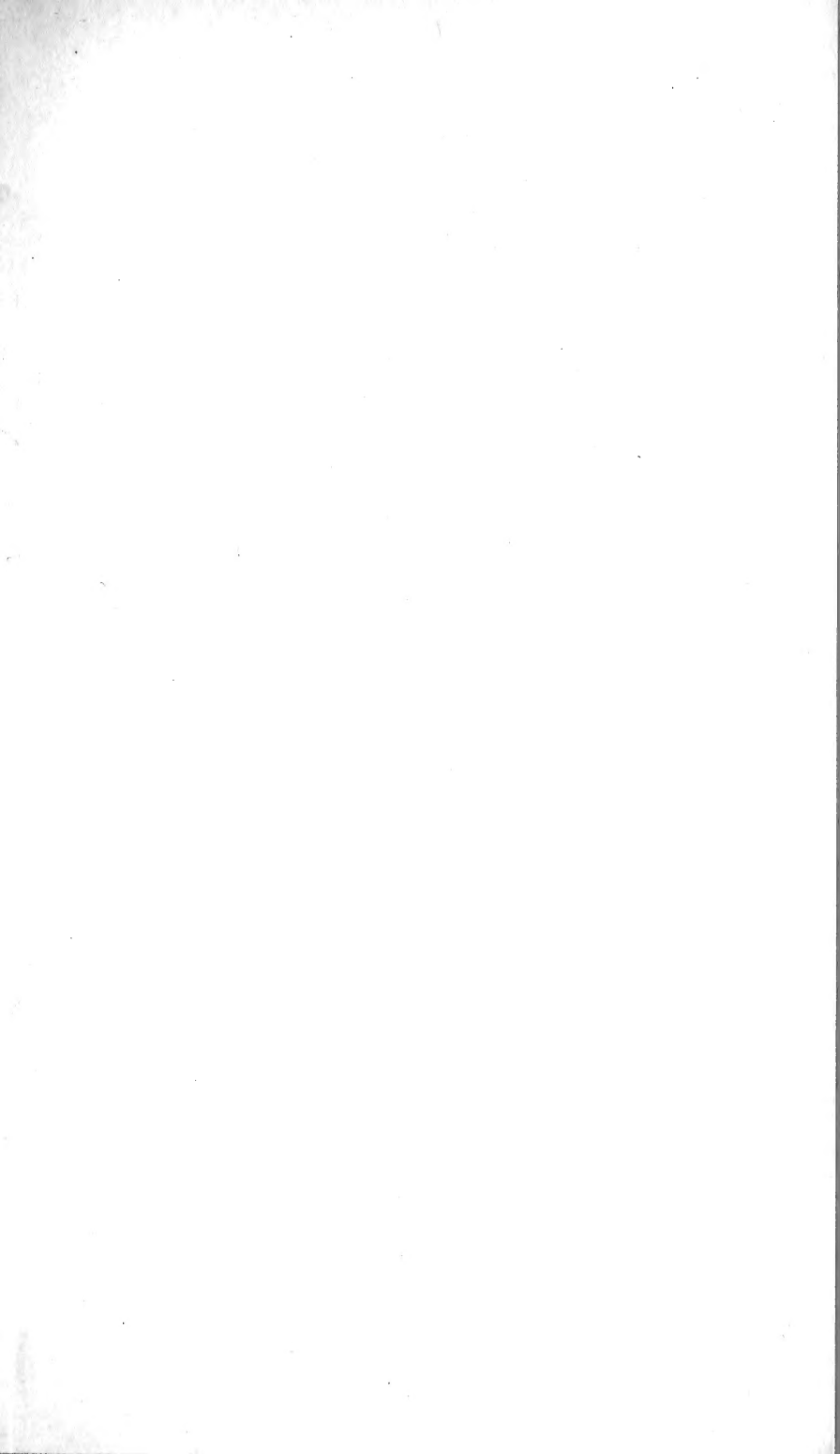
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PROCEEDINGS

78 AND

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

VOL. XI.

SESSION 1896-97.

LIVERPOOL :

PRINTED BY T. DOBB & Co., 229, BROWNLOW HILL.

1897.



§ Mar. Inv.

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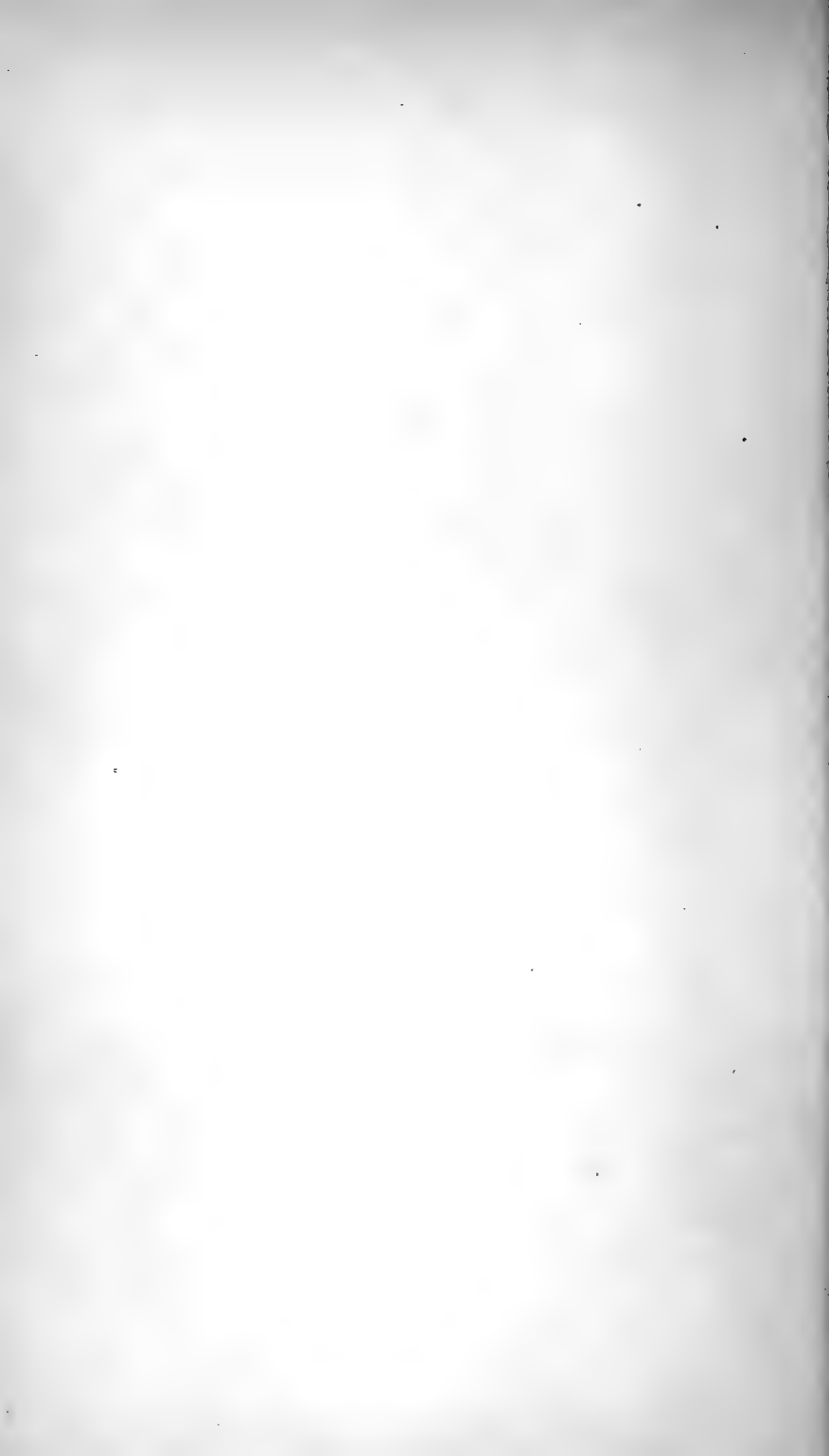
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PROCEEDINGS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.



OFFICE-BEARERS AND COUNCIL.

Ex-Presidents :

1886—87 PROF. W. MITCHELL BANKS, M.D., F.R.C.S.
1887—88 J. J. DRYSDALE, M.D.
1888—89 PROF. W. A. HERDMAN, D.Sc., F.R.S.E.
1889—90 PROF. W. A. HERDMAN, D.Sc., F.R.S.E.
1890—91 T. J. MOORE, C.M.Z.S.
1891—92 T. J. MOORE, C.M.Z.S., A.L.S.
1892—93 ALFRED O. WALKER, J.P., F.L.S.
1893—94 JOHN NEWTON, M.R.C.S.
1894—95 PROF. F. GOTCH, M.A., F.R.S.
1895—96 PROF. R. J. HARVEY GIBSON, M.A.

SESSION XI., 1896-97.

President :

HENRY O. FORBES, LL.D., F.Z.S.

Vice-Presidents :

PROF. R. J. HARVEY GIBSON, M.A.
PROF. W. A. HERDMAN, D.Sc., F.R.S.

Hon. Treasurer :

ISAAC C. THOMPSON, F.L.S., F.R.M.S.

Hon. Librarian :

ANDREW SCOTT.

Hon. Secretary :

JOSEPH A. CLUBB, B.Sc. (VICT.).

Council :

H. C. BEASLEY.	G. H. MORTON, F.G.S.
K. GROSSMANN, M.D.	T. C. RYLEY.
W. J. HALLS.	W. E. SHARP.
PROF. S. J. HICKSON, D.Sc. F.R.S.	PROF. SHERRINGTON, M.D.
REV. L. de B. KLEIN, D.Sc.	A. T. SMITH, JUN.
REV. T. S. LEA, M.A.	A. O. WALKER, F.L.S.

REPORT of the COUNCIL.

DURING the Session 1896-97 there have been eight ordinary meetings and one field meeting of the Society. The latter was held at Hooton, and as the day was bright and fine, a very profitable and enjoyable afternoon was spent in searching the ponds and ditches of the neighbourhood.

The communications made to the Society have been representative of almost all branches of Biology, and many interesting exhibits have been submitted at the meetings.

Following the custom of former years, Professor A. C. Haddon, M.A., was invited to deliver an address before the Society. The wisdom of thus bringing in a distinguished Biologist from another centre was again evidenced, when a large audience assembled to hear an intensely interesting lecture on Anthropology, entitled "How and Why we Study Man."

The Library continues to make satisfactory progress as shown by the Librarian's Report which follows.

The Treasurer's usual statement and balance sheet are appended.

No alterations have been made in the Laws of the Society during the past session.

The members at present on the roll are as follows:—

Honorary Members.....	9
Ordinary Members.....	61
Student Members.....	15
<hr/>	
Total	85

SUMMARY of PROCEEDINGS at the MEETINGS.

The first meeting of the eleventh session was held at University College on Friday, 9th October, 1896.

1. The first part of the proceedings took place in the large Zoology Laboratory from 7 to 7-30 o'clock. Tea was served at one end of the room and on the tables were a number of exhibits, including two native "fetishes" from the West Coast of Africa; and casts of *Sphenodon punctatus*, the Tua-tua of New Zealand, and of the lower jaws of *Amphitherium oweni* from the Stonesfield Slate.

The President-elect (Henry O. Forbes, LL.D., F.Z.S.,) took the chair at 7-30 o'clock, in the Zoology Theatre.

2. The Report of the Council on the Session 1895-96 (see "Proceedings," Vol. X., p. viii.) was read and adopted.
3. The Treasurer's Balance Sheet for the Session 1895-96 (see "Proceedings," Vol. X., p. xxx.) was submitted and approved.
4. The Librarian's Report (see "Proceedings," Vol. X., p. xxiv.) was submitted and approved.
5. The following Office-bearers and Council for the ensuing Session were elected:—Vice-Presidents, Prof. Harvey Gibson, M.A., Prof. W. A. Herdman, D.Sc., F.R.S.; Hon. Treasurer, I. C. Thompson, F.L.S., F.R.M.S.; Hon. Librarian, Andrew Scott; Hon. Secretary, Joseph A. Clubb, B.Sc. (Vict.); Council, H. C. Beasley, K. Grossmann, M.D., W. J. Halls, Prof. S. J. Hickson, D.Sc., F.R.S., Rev. L. de Beaumont Klein, D.Sc., Rev. T. S. Lea, M.A.,

G. H. Morton, F.G.S., T. C. Riley, W. E. Sharp, Prof. Sherrington, M.D., F.R.S.; A. T. Smith, Jun., and A. O. Walker, F.L.S.

6. The President delivered the Inaugural Address, entitled "Biological Institutions in Liverpool, during the present century" (see "Transactions," p. 1). A vote of thanks proposed by Prof. Herdman, seconded by Mr. Alf. O. Walker, was carried with acclamation.

The second meeting of the eleventh session was held at University College on Friday, November 13th, 1896. The President in the chair.

1. The following exhibits among others were on view in the Zoological Laboratory from 7 to 7-30 o'clock:—
A series of marine algæ from Port Erin, mounted by the Rev. T. S. Lea, who explained his method of mounting.
2. Professor Herdman gave an address on the Menhirs and Dolmens of Brittany, illustrated by about 70 lantern photographs of these and other prehistoric remains chiefly from the neighbourhood of Carnac in the Morbihan. In concluding he drew attention to the possibility that the "Calderstones" in the neighbourhood of Liverpool may be the remains of a dolmen. This led to a discussion which was continued in the Daily Papers and the more important part of which has at the request of the Council, been collected and reprinted (see "Transactions," p. 132).

The third meeting of the eleventh session was held conjointly with the Chemical Society of University College on Friday, December 11th, 1896, for the purpose of

hearing a lecture by Prof. Ramsay, of University College, London, on "Helium and Argon." The lecture was of great interest, and much enjoyed by the large number of members of the Biological Society who were present.

The fourth meeting of the eleventh session was held at University College on Friday, January 15th, 1897. The President in the chair.

1. The first part of the meeting (from 7 to 7-30) was held in the new Natural History Museum of University College to enable Mr. H. C. Beasley to give a demonstration on the collection of fossil footprints there contained, from the Triassic formation of the neighbourhood.

Mr. Chadwick exhibited also a series of microscopic slides of surface organisms, tow-netted in Port Erin Bay.

2. The congratulations of the Society, were on the motion of Prof. Herdman, accorded to Mr. J. Lomas, A.R.C.S., on the honour done him, by the award of the Geological Society of London, of a portion of the Lyell Fund, in recognition of his researches in Glacial Geology.
3. Mr. H. C. Beasley communicated a note on a fossil footprint found at Storeton, together with a letter on the same from Prof. Seeley (see "Transactions," p. 179).
4. Mr. J. Lomas laid before the Society the first part of his paper on the Geology of the Irish Sea. This will be published in a succeeding volume of the "Transactions," along with the remaining portion of the paper.
5. Prof. Herdman submitted the Annual Report of the L.M.B.C. and Port Erin Biological Station (see "Transactions," p. 7).

The fifth meeting of the eleventh session was held at University College on Friday, February 12th, 1897. The President in the chair.

1. In the Zoology Laboratory, from 7 to 7-30 were a number of miscellaneous exhibits.
 2. A Flying-Fish (*Exocætus volitans*), was exhibited infested with two specimens of the parasitic Copepod, *Penella blainvillii*, which in turn were covered with a number of small Cirripedes (*Conchoderma virgata*). An interesting discussion followed, in which remarks were made by Mr. I. C. Thompson, Mr. J. A. Clubb and others.
 3. Mr. E. T. Browne, F.Z.S., contributed a revised list of the Hydromedusæ of the L.M.B.C. District (see "Transactions," p. 147). Communicated by Mr. I. C. Thompson.
 4. Mr. A. J. Ewart, D.Sc., Ph.D., contributed a paper on the power of Plants to withstand dessication (see "Transactions," p. 151). Communicated by the Hon. Secretary.
-

The sixth meeting of the eleventh session was held in University College on Friday, March 12th, 1897. The President in the chair.

1. In the Zoology Laboratory, Professor Herdman exhibited, with remarks, an abnormal skull of a rabbit, and a specimen of a new species of Gephyrean worm probably of the genus *Thalassema*, with a peculiar green colouring matter.
2. Professor Herdman gave a very interesting address on "Field Work in Marine Zoology; its Scientific and Economic Aspect." The scope of marine zoology was first touched upon, and the lecturer showed how a thoroughly scientific knowledge of the life-histories, habits, and food supply of the

edible marine fishes must be of the greatest possible advantage in our Sea-Fisheries. The address was illustrated by lantern slides.

The seventh meeting of the eleventh session was held in University College on Friday, April 9th, 1897. The President in the chair.

1. In the Zoology Laboratory, among other exhibits was a series of drawings of Echinoderm larvæ made by Mr. H. C. Chadwick from specimens obtained in the tow-net.
 2. The President gave an interesting lecture on "New Guinea; the Country and its Inhabitants, from Personal Observation." Aided by a magnificent series of lantern slides, many of them prepared from original negatives, a vivid description of the country was given; and many personal incidents were related, which were highly instructive of the customs and habits of the people. The peculiar fauna of New Guinea was referred to, and a number of its more brightly plumaged birds were on exhibition. A hearty vote of thanks was accorded to Dr. Forbes for his address.
-

The eighth meeting of the eleventh session was held in University College on Friday, May 14th, 1897. The Vice-President (Prof. Herdman) in the chair.

1. In the Zoology Laboratory, among other exhibits, Mr. Edward Cox described some worked flints found at Spital.
2. A paper on the Turbellarians of the L.M.B.C. District, by H. Lyster Jameson, B.A., of the Royal College of Science, London, was submitted (see "Transactions," p. 160).

3. The second report of the Copepoda, from the West Coast of Ireland, by Mr. I. C. Thompson (see "Transactions," p. 127).
 4. Prof. A. C. Haddon gave an address on Anthropology, entitled "How and Why we Study Man." Many of the physical characteristics of mankind were first dealt with, and the distribution of the light and dark haired varieties in Europe were graphically shown on the screen by means of diagrams. The second part of the lecture dealt more with the psychological aspect, and was of the most interesting character. The lecturer referred to many of the customs of primitive races, and showed a real connection between them and many of the children's games as played in our villages at the present day. The address was illustrated with lantern slides, and was greatly enjoyed by a large audience. On the motion of Dr. Klein, seconded by Dr. Newton, a cordial vote of thanks was passed with acclamation.
-

The ninth and last meeting of the eleventh session (the Annual Field Meeting) was held at Hooton on Saturday, June 12th. The day was fine, and a very pleasant afternoon was spent searching the ponds and ditches in the neighbourhood. After tea a short business meeting was held, when Mr. I. C. Thompson, F.L.S., proposed by Dr. Forbes, seconded by Mr. W. E. Sharp, was elected President for next session.

LAWS of the LIVERPOOL BIOLOGICAL SOCIETY.

I.—The name of the Society shall be the “LIVERPOOL BIOLOGICAL SOCIETY,” and its object the advancement of Biological Science.

II.—The Ordinary Meetings of the Society shall be held at University College, at Seven o'clock, during the six Winter months, on the second Friday evening in every month, or at such other place or time as the Council may appoint.

III.—The business of the Society shall be conducted by a President, two Vice-Presidents, a Treasurer, a Secretary, a Librarian, and twelve other Members, who shall form a Council; four to constitute a quorum.

IV.—The President, Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be elected annually, by ballot, in the manner hereinafter mentioned.

V.—The President shall be elected by the Council (subject to the approval of the Society) at the last Meeting of the Session, and take office at the ensuing Annual Meeting.

VI.—The mode of election of the Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be in the form and manner following:—It shall be the duty of the retiring Council at their final meeting to suggest the names of Members to fill the offices of Vice-Presidents, Treasurer, Secretary, Librarian, and of four Members who were not

on the last Council to be on the Council for the ensuing session, and formally to submit to the Society, for election at the Annual Meeting, the names so suggested. The Secretary shall make out and send to each Member of the Society, with the circular convening the Annual Meeting, a printed list of the retiring Council, stating the date of the election of each Member, and the number of his attendances at the Council Meetings during the past session; and another containing the names of the Members suggested for election, by which lists, and no others, the votes shall be taken. It shall, however, be open to any Member to substitute any other names in place of those upon the lists, sufficient space being left for that purpose. Should any list when delivered to the President contain other than the proper number of names, that list and the votes thereby given shall be absolutely void. Every list must be handed in personally by the Member at the time of voting. Vacancies occurring otherwise than by regular annual retirement shall be filled by the Council.

VII.—Every Candidate for Membership shall be proposed by three or more Members, one of the proposers from personal knowledge. The nomination shall be read from the Chair at any Ordinary Meeting, and the Candidate therein recommended shall be balloted for at the succeeding Ordinary Meeting. Ten black balls shall exclude.

VIII.—When a person has been elected a Member, the Secretary shall inform him thereof, by letter, and shall at the same time forward him a copy of the Laws of the Society.

IX.—Every person so elected shall within one calendar month after the date of such election pay an Entrance Fee of Half a Guinea and an Annual Subscription of One

Guinea (except in the case of Student Members); but the Council shall have the power, in exceptional cases, of extending the period for such payment. No Entrance Fee shall be paid on re-election by any Member who has paid such fee.

X.—The Subscription (except in the case of Student Members) shall be One Guinea per annum, payable in advance, on the day of the Annual Meeting in October.

XI.—Members may compound for their Annual Subscription by a single payment of Ten Guineas.

XII.—There shall also be a class of Student Members, paying an Entrance Fee of Two Shillings and Sixpence, and a Subscription of Five Shillings per annum.

XIII.—All nominations of Student Members shall be passed by the Council previous to nomination at an Ordinary Meeting. When elected, Student Members shall be entitled to all the privileges of Ordinary Members, except that they shall not receive the publications of the Society, nor vote at the Meetings, nor serve on the Council.

XIV.—Resignation of Membership shall be signified *in writing* to the Secretary, but the Member so resigning shall be liable for the payment of his Annual Subscription, and all arrears up to date of his resignation.

XV.—The Annual Meeting shall be held on the second Friday in October, or such other convenient day in the month as the Council may appoint, when a Report of the Council on the affairs of the Society, and a Balance Sheet duly signed by the Auditors previously appointed by the Council, shall be read.

XVI.—Any person (not resident within ten miles of Liverpool) eminent in Biological Science, or who may have rendered valuable services to the Society, shall be eligible

as an Honorary Member; but the number of such Members shall not exceed fifteen at any one time.

XVII.—Captains of vessels and others contributing objects of interest shall be admissible as Associates for a period of three years, subject to re-election at the end of that time.

XVIII.—Such Honorary Members and Associates shall be nominated by the Council, elected by a majority at an Ordinary Meeting, and have the privilege of attending and taking part in the Meetings of the Society, but not voting.

XIX.—Should there appear cause in the opinion of the Council for the expulsion from the Society of any Member, a Special General Meeting of the Society shall be called by the Council for that purpose; and if two-thirds of those voting agree that such Member be expelled, the Chairman shall declare this decision, and the name of such Member shall be erased from the books.

XX.—Every Member shall have the privilege of introducing one visitor at each Ordinary Meeting. The same person shall not be admissible more than twice during the same session.

XXI.—Notices of all Ordinary or Special Meetings shall be issued to each Member by the Secretary, at least three days before such Meeting.

XXII.—The President, Council, or any ten Members can convene a Special General Meeting, to be called within fourteen days, by giving notice in writing to the Secretary, and stating the object of the desired Meeting. The circular convening the Meeting must state the purpose thereof.

XXIII.—Votes in all elections shall be taken by ballot, and in other cases by show of hands, unless a ballot be first demanded.

XXIV.—No alteration shall be made in these Laws, except at an Annual Meeting, or a Special Meeting called for that purpose; and notice in writing of any proposed alteration shall be given to the Council, and read at the Ordinary Meeting, at least a month previous to the meeting at which such alteration is to be considered, and the proposed alteration shall also be printed in the circular convening such meeting; but the Council shall have the power of enacting such Bye-Laws as may be deemed necessary, which Bye-Laws shall have the full power of Laws until the ensuing Annual Meeting, or a Special Meeting convened for their consideration.

BYE - LAW .

Student Members of the Society may be admitted as Ordinary Members without re-election upon payment of the Ordinary Member's Subscription; and they shall be exempt from the Ordinary Member's entrance fee.

LIST of MEMBERS of the LIVERPOOL
BIOLOGICAL SOCIETY.

SESSION 1896-97.

A. ORDINARY MEMBERS.

(Life Members are marked with an asterick.)

ELECTED.

- 1886 Banks, Prof. W. Mitchell, M.D., F.R.C.S., 28,
Rodney-street
- 1886 Barron, Prof. Alexander, M.B., M.R.C.S., 34,
Rodney-street
- 1888 Beasley, Henry C., Prince Albert-road, Wavertree
- 1894 Boyce, Prof., University College, Liverpool
- 1889 Brown, Prof. J. Campbell, 8, Abercromby-square
- 1887 Caine, Nathaniel, Spital, Bromborough
- 1886 Caton, R., M.D., F.R.C.P., Lea Hall, Gateacre
- 1886 Clubb, J. A., M.Sc., HON. SECRETARY, Free
Public Museum, Liverpool
- 1890 Davies, D., Alexandra-mount, Litherland.
- 1891 Dismore, Miss, 65, Shewsbury-road, Oxton
- 1890 Ewart, A. J., D.Sc., 33, Berkley-street, Liverpool
- 1894 Forbes, H. O., LL.D., F.Z.S., PRESIDENT, Free
Public Museum, Liverpool
- 1891 Garstang, W., M.A., Lincoln College, Oxford
- 1886 Glynn, Prof. T. R., M.D., F.R.C.P., 62, Rodney-
street
- 1886 Gibson, Prof. R. J., M.A., F.L.S., VICE-PRESIDENT,
University College
- 1894 Grossmann, Karl, M.D., 70, Rodney-street
- 1886 Halls, W. J., 35, Lord-street
- 1896 Haydon, W. H., 24, Upper Parliament-street

- 1886 Herdman, Prof. W. A., D.Sc., F.R.S., VICE-PRESIDENT, University College
1893 Herdman, Mrs., B.Sc., Croxteth Lodge, Ullet-road, Liverpool
1891 Hicks, J. Sibley, M.D., 2, Erskine-street
1894 Hickson, Prof. S. J., Owens College, Manchester
1888 *Hurst, C. H., Ph.D., 20, Adelaide-road, Dublin
1886 Jones, Charles W., Field House, Prince Alfred-road, Wavertree
1896 Jones, R., 3a, Lord-street
1894 Jones, Charles Elpie, B.Sc., Prenton-rd. W., B'head
1895 Klein, Rev. L. de Beaumont, D.Sc., F.L.S., 6, Devonshire-road
1894 Lea, Rev. T. S., 3, Wellington Fields, Wavertree
1896 Laverock, W. S., M.A., B.Sc., Free Museum, Liverpool
1886 Lomas, J., Assoc. N.S.S., 16, Mellor-road, B'head
1893 Macdonald, J. S., B.A., 21, Hatherley-st., L'pool
1888 Melly, W. R., 90, Chatham-street
1886 Morton, G. H., F.G.S., 209, Edge-lane, E.
1888 Newton, John, M.R.C.S., 44, Rodney-street
1887 Narramore, W., F.L.S., 5, Geneva-road, Elm Park
1894 Paterson, Prof., M.D., M.R.C.S., University College, Liverpool
1894 Paul, Prof. F. T., Rodney-street, Liverpool
1892 Phillips, E., L.D.S., M.R.C.S., 33, Rodney-street
1896 Picton, W. H., 2, College-road, Gt. Crosby
1886 *Poole, Sir James, J.P., Abercromby-square
1890 Rathbone, Miss May, Backwood, Neston
1895 Ricketts, C., M.D., 11, Hamilton-square, B'head
1887 Robertson, Helenus R., Springhill, Church-road, Wavertree
1887 Ryley, Thomas C., 10, Waverley-road
1892 Sephton, Rev. J., M.A., 90, Huskisson-street

- 1894 Scott, Andrew, HON. LIBRARIAN, University College, Liverpool
- 1895 Sherrington, Prof., M.D., F.R.S., University College, Liverpool
- 1891 Sharp, W. E., The Woodlands, Ledsham
- 1886 Smith, Andrew T., Jun., 13, Bentley-road, Prince's Park
- 1895 Smith, J., Rose Villa, Lachford, Warrington
- 1893 Tate, Francis, F.C.S., 9, Hackins Hey, Liverpool
- 1886 Thompson, Isaac C., F.L.S., F.R.M.S., HON. TREASURER, 53, Croxteth-road
- 1889 Thornely, Miss L. R., Baycliff, Woolton Hill
- 1888 Toll, J. M., Kirkby Park, Kirkby
- 1886 Walker, Alfred O., J.P., F.L.S., Colwyn Bay
- 1889 Williams, Miss Leonora, Hill Top, Bradfield, nr. Sheffield
- 1891 Wigglesworth, J., M.D., County Asylum, Rainhill
- 1896 Woods, Joseph A., L.D.S. Eng., 76, Mount-pleasant, Liverpool
- 1892 Weiss, Prof., Owens College, Manchester
- 1896 Willmer, Miss J. H., 20, Lorne-rd., Oxtou, B'head
- 1892 Young, T. F., M.D., 12, Merton-road, Bootle

B. STUDENT MEMBERS.

- Armstrong, Miss A., 26, Trinity-road, Bootle
- Bennette, Horace W. P., Gothic Lodge, Park-road, S., Birkenhead
- Burnet, R., University College, Liverpool
- Chadwick, H. C., Free Museum, Bootle
- Christophers, S. R., M.D., 10, Lily-road, Fairfield
- Crompton, Miss C. A., University College, Liverpool
- Dickinson, T., 3, Clark-street, Prince's Park
- Hannah, J. H. W., 61, Avondale-road, Sefton Park
- Harrison, Oulton, Denehurst, Sandown Park, Wavertree

Henderson, W. S., B.Sc., Beech-hill, Fairfield
Hurter, D. G., Holly Lodge, Cressington
Linton, S. F., St. Pauls Vicarage, Clifton-road, Birkenhead
Phillips, Miss F., 3, Green-lawn, Rock Ferry
Quinby, F. G., 11, Belvidere-road, Liverpool
Simpson, A. Hope, Annandale, Sefton Park

C. HONORARY MEMBERS.

H.S.H. Albert I., Prince of Monaco, 25, Faubourg St.
Honore, Paris
Bornet, Dr. Edouard, Quai de la Tournelle 27, Paris
Claus, Prof. Carl, University, Vienna
Fritsch, Prof. Anton, Museum, Prague, Bohemia
Giard, Prof. Alfred, Sorbonne, Paris
Haeckel, Prof. Dr. E., University, Jena
Hanitsch, R., Ph.D., Raffles Museum, Singapore
Leicester, Alfred, Buckhurst Farm, nr. Edenbridge, Kent
Solms-Laubach, Prof. Dr., Botan. Instit., Strassburg

REPORT of the LIBRARIAN.

Our Society has arranged two additional exchanges of publications since the last Report, making in all seventy-eight societies and institutions.

The following list gives the titles of the exchanges and donations received during the session :—

1. Amsterdam, Académie Royale des Sciences. Vol. VI., part 2, Nos. 7—9; vol. V., part 2, Nos. 1—3, *Jaarboek*, 1895.
2. Batavia, Société Royale des Sciences Naturelles des Indes Néerlandaises. *Catalogue Supplémentaire*, 1883-93; vol. LV., *Boekwerken*, etc., 1895.
3. Bergen Museum, an account of the Crustacea of Norway by G. O. Sars. Vol. II., *Isopoda*, parts 1 and 2.
4. Bergen Museum, *Aarbog*, for 1896.
5. Berlin, Konig. preus. Akad. d. Wissenschaften, Sitz. Nos. 39—53.
6. Berlin, Konig. preus. Akad. d. Wissenschaften, *Mathem. u. Natur.*, *Mittheil.* Parts 8—10; 1895; 1896.
7. Birmingham, *Proceedings of the Natural History and Philosophical Society*. Vol. IX., part 2.
8. Bologna, *Accademia d. Scienze; Sezione d. Scienze d. Naturali*. *Memorie Ser. V.*, vol. IV.
9. Bologna, *Accademia d. Scienze; Sezione d. Medicina e. Chirurgia*. *Memorie Ser. V.*, vol. IV.
10. Bonn, *Naturhistorischen verein des Preussichen Rheinlande u. Westfalens*, Sitz. 1896, parts 1 and 2.
11. Bonn, *Naturhistorischen verein des Preussichen Rheinlande u. Westfalens*, *Verhandl.* 1896, parts 1 and 2.
12. Bordeaux, *Proces-Verbaux de la Societe Linneenne*. Vol. XLVIII.
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85. On two new species of Amphipoda Gammarina. By A. O. Walker (Ann. and Mag. Nat. Hist., ser. VI., vol. XVII., May, 1896). Presented by A. O. Walker, Esq., F.L.S.
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87. Report on the Schizopoda, Cumacea, Isopoda and Amphipoda of the Channel Islands. By A. O. Walker, F.L.S. and James Hornell. Presented by A. O. Walker, F.L.S.
88. On *Scolecithrix hibernica* a new species of Copepod, with some remarks on the distribution of the Crustacea. By Andrew Scott. Presented by the Author.
89. Résultats des Campagnes Scientifiques Accomplies sur son yacht. Par Albert 1^{er} Prince Souverain de Monaco. Vol. X. Presented by H.S.H. The Prince of Monaco.
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91. Eine Studieureise in Angelegenheiten der Fischerei. Von Prof. Dr. Anton Fritsch. Presented by the Author.
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- AMSTERDAM.—Koninklijke Akadademie van Wettenschappen.
 Koninklijke Zoölogisch Genootschap Natura Artis Magistra.
- BALTIMORE.—Johns Hopkins University.
- BATAVIA.—Koninklijke Natuurkundig Vereeniging in Ned. Indie.
- BERGEN.—Museum.
- BERLIN.—Konigl. Akadémie der Wissenschaften.
 Deutscher Fischerei-Vereins.
- BIRMINGHAM.—Philosophical Society.
- BOLONGA.—Accademia delle Scienze.
- BONN.—Naturhistorischer verein des Preussichen Rheinlande und Westfalens.
- BORDEAUX.—Société Linnéenne.
- BOSTON.—Society of Natural History.
- BRUSSELS.—Académie Royal des Sciences, etc., de Belgique.
- CAMBRIDGE.—Morphological Laboratories.
- CAMBRIDGE, MASS.—Museum of Comparative Zoology of Harvard College.
- CHRISTIANIA.—Videnskabs-Selskabet.
- DUBLIN.—Royal Dublin Society.
- EDINBURGH.—Royal Society.
 Royal Physical Society.
 Royal College of Physicians.
 Fishery Board for Scotland.
- FRANKFURT.—Senckenbergische Naturforschende Gesellschaft.
- FREIBURG.—Naturforschende Gesellschaft.
- GENEVE.—Société de Physique et d'Histoire Naturelle.
- GIESSEN.—Oberhessische Gesellschaft für Natur und Heilkunde.
- GLASGOW.—Natural History Society.
- GOTTINGEN.—Konigl. Gesellschaft der Wissenschaften.
- HALIFAX.—Nova Scotian Institute of Natural Science.
- HARLEM.—Musée Teyler.
 Société Hollandaise des Sciences.
- *HELGOLAND.—Königliche Biologische Anstalt.
- KIEL.—Naturwissenschaftlichen vereins für Schleswig—Holstein.
 Kommission für der Untersuchung der Deutschen meere.
- KJØBENHAVN.—Naturhistoriske Forening.
 Danish Biological Station (C. G. John Petersen).
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- LILLE.—Revue Biologique du Nord de la France.

XXX. LIVERPOOL BIOLOGICAL SOCIETY.

LONDON.—Royal Microscopical Society.

British Museum (Natural History Department).

MANCHESTER.—Microscopical Society.

Owens College.

MARSEILLES.—Station Zoologique d'Endoume.

Musée d'Histoire Naturelle.

MASSACHUSETTS.—Tufts College Library.

MECKLENBURG.—Vereins der Freunde der Naturgeschichte.

MELBOURNE.—Royal Society of Victoria.

MONTPELLIER.—Académie des Sciences et Lettres.

MOSCOU.—Société Impériale des Naturalistes.

NANCY.—Société des Sciences.

NAPOLI.—Accademia delle Scienze Fisiche e Matematiche.

NEW BRUNSWICK.—Natural History Society.

OPORTO.—Annaes de Sciencias Naturaes.

PARIS.—Museum d'Histoire Naturelle.

Société Zoologique de France.

Bulletin Scientifique de la France et de la Belgique.

PHILADELPHIA.—Academy of Natural Sciences.

PLYMOUTH.—Marine Biological Association.

ST. LOUIS, MISS.—Academy of Science.

ST. PETERSBURG.—Académie Impériale des Sciences.

*SAN FRANCISCO.—California Academy of Science.

SANTIAGO.—Société Scientifique du Chili.

STAVANGER.—Stavanger Museum.

STOCKHOLM.—Académie Royale des Sciences.

SYDNEY.—Australian Museum.

TOKIO.—Imperial University.

TORINO.—Musei de Zoologia ed Anatomia Comparata della R. Università.

TORONTO.—Canadian Institute.

TRIESTE.—Società Adriatica de Scienze Naturali.

UPSALA.—Upsala Universitet.

WASHINGTON.—Smithsonian Institution.

United States National Museum.

United States Commission of Fish and Fisheries.

WELLINGTON, N.Z.—New Zealand Institute.

WIEN.—K. K. Naturhistorischen Hofmuseums.

K. K. Zoologisch—Botanischen Gesellschaft.

ZURICH.—Zürcher Naturforschende Gesellschaft.

Those marked with * are the additions.

THE LIVERPOOL BIOLOGICAL SOCIETY.

Dr.

IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER.

Cr.

1897.		1897.	
	£ s. d.		£ s. d.
To Use of Rooms, University College	3 3 0	By Balance, 30th September, 1896	55 13 4
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" Balance in hand, September 30th, 1897.....	79 18 7		
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		By Balance in hands of Treasurer	£79 18 7

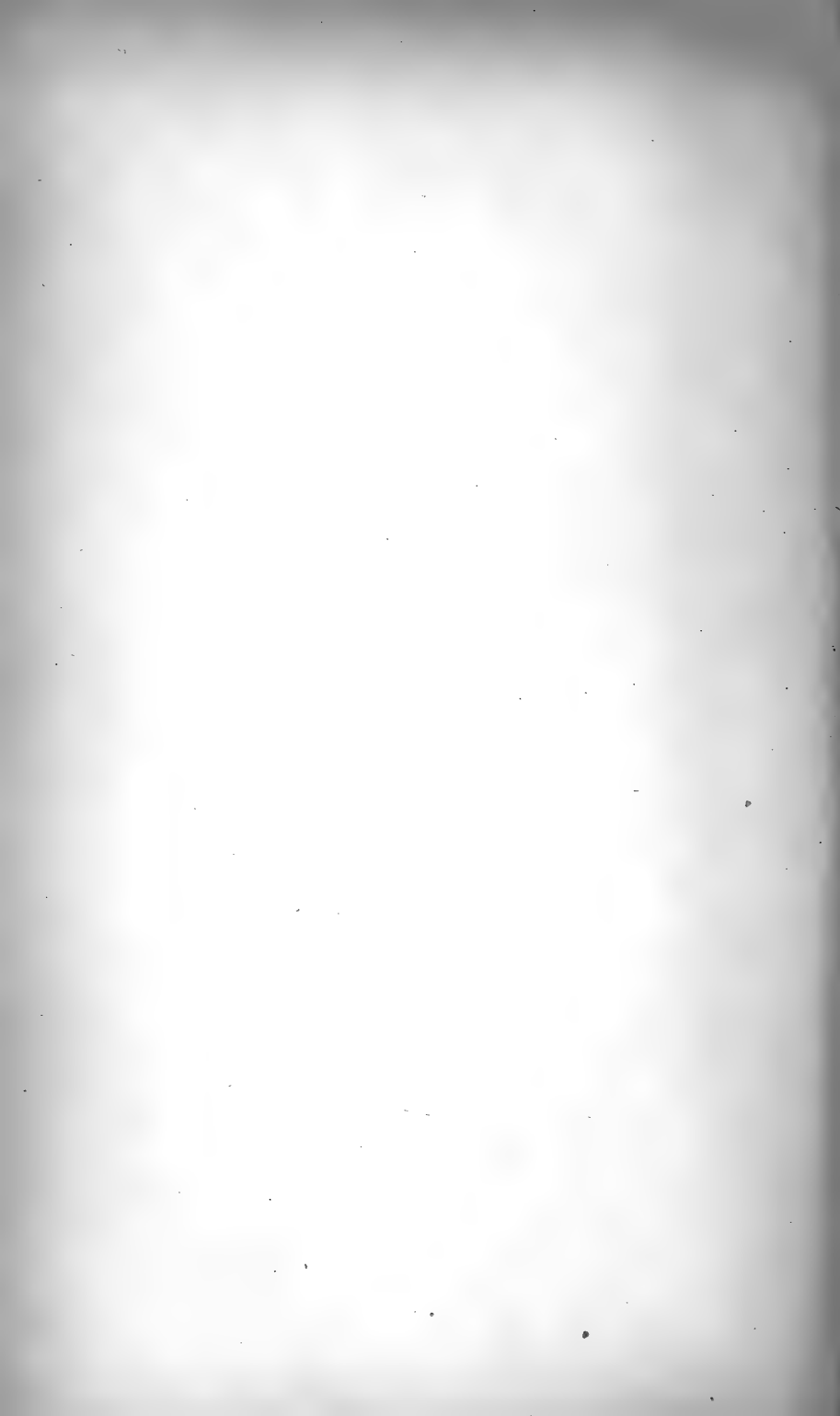
ISAAC C. THOMPSON,

HON. TREASURER.

LIVERPOOL, September 30th, 1897.

Audited and found correct,

A. T. SMITH, JUNR.



TRANSACTIONS
OF THE
LIVERPOOL BIOLOGICAL SOCIETY.

PRESIDENTIAL ADDRESS
ON
BIOLOGICAL INSTITUTIONS IN LIVERPOOL,
DURING THE PRESENT CENTURY.

BY
H. O. FORBES, LL.D., F.R.G.S., F.Z.S.,
DIRECTOR OF MUSEUMS TO THE CORPORATION OF LIVERPOOL.

MY first and most pleasant duty this evening is to express my sincere thanks to the Society for the high honour they have done me in electing me to preside over their deliberations during the coming session. It was with considerable reluctance that I agreed to accept this distinction, because I felt, and shall feel, that the period of my connection with the Society has been very short, and there are older members whose claims I should consider greater than any I possess, except interest in the welfare of the Society and desire to aid in its advancement. The honour you have done me I acknowledge, and I appreciate the good opinion and kind feeling of the Society towards me. I shall endeavour to earn your approval by giving my best powers to the fulfilment of the duties that appertain to the office, at the same time claiming your indulgence wherein I fail to attain to the excellencies of my predecessors in this chair.

In turning over in my mind for a subject on which to address you this evening, I found I had not at my command any purely biological subject which was not too technical for the occasion. Being sensible, in common no doubt with many others of the stimulus to increased activity derived from the meeting of the British Association among us, I have thought that it might not be unprofit-

able to review what had been done for biological science—used in it widest sense in this city in the past century, and the prospects for its advance in the future.

A short account was given of the various Biological Institutions that arose, or flourished, in Liverpool in each of the nine and a half decades of the present century; the following being mentioned:—

Between 1800—1810.

The Botanic Gardens.

Bullock's Liverpool Museum.

Between 1811—1820.

The Literary and Philosophical Society.

The Liverpool Institution.

Between 1821—1830.

The Royal Institution (The Chartered Liverpool Institution).

Between 1831—1840.

The British Association Meeting.

The Natural History Society and its Museum.

The Zoological Gardens.

Between 1841—1850.

Amalgamation of Natural History Society and the Literary and Philosophical Society.

The Historic Society of Lancashire and Cheshire.

Between 1851—1860.

The British Association Meeting.

The Derby (Zoological) Collection presented to the City.

The Free Public Museum and Library established.

The Field Naturalists' Club.

The Geological Society.

Between 1861—1870.

Publication of Morton's Geology of the country round Liverpool.

The Liverpool Association of Science and Arts.

The School of Science.

The Liverpool Microscopical Society.

Between 1871—1880.

The Lancashire and Cheshire Entomological Society.

Foundation of University College.

Between 1881—1890.

Foundation of the Derby Chair of Natural History in
University College.

The Liverpool Marine Biological Committee.

The Biological Society.

After 1890.

Foundation of the Chair of Botany in University
College.

Meeting of the British Association for the third time.

Such is a short and imperfect sketch, if not of all, certainly of the chief, Institutions that have kept alive the love of Science and advanced its progress during the century fast drawing to a close. The perfection of the Microscope, in which Lister's name stands eminent, and of the methods of investigation, and the creation of the Science of Embryology have, within even the short period of the memory of some of us who are not yet very old, revolutionised our Biological ideas, and opened out before us new problems for investigation in every direction, and as the advances made since 1860 have been gigantic, those of the coming equal period will undoubtedly proceed with increasing ratio. And this city, proud of its superiority in the commerce of the world, and daily attaining to a more exalted position among the intellectual forces of the country, behoves to take a large share in those advances. The local work to be done is very great; there is scarcely a single species, even our commonest, that will not repay further investigation. What is needed among us is closer

union among our biological societies; and closer intercourse among their workers. In the days when no relationships were recognised between different groups of living things, the union of societies cultivating different branches of Science might appear of little moment; but, as is now fully recognised, no branch is independent, the greatest possible benefit must accrue from the more intimate union of our various societies.

Much money now spent in machinery, libraries, and publications by our separate societies if funded together would be saved, to be spent on profitable original research and the publication of these results and of new facts and observations, which would command the attention of the scientific world. The valuable investigations of some of our smaller societies are lost to a great extent by being either not published, or buried in small Proceedings, which fail to obtain wide dissemination. Some of our societies again spend large sums in printing papers, which in being often condensations of other men's work, and not original contributions to knowledge, though excellent as a means of diffusing knowledge when read before the society, do not call for publication; indeed they undoubtedly reduce the value of the Proceedings in which they are re-produced by increasing the price of the volume, and thereby limiting its dissemination, if not even discrediting that society's publications, so much that their volumes are rarely consulted. In other societies where the funds are small, the communications of the members have to be contributed to metropolitan or other journals. The want of amalgamation—this working as units—and the want of organisation, is the cause of so much less being accomplished than might be done.

I cannot help expressing how great a disappointment to many of us it was that the negotiations last year for our

union with the Microscopical Society should have fallen through. I am still hopeful that the union between us is but delayed for a short period. That the Entomological Society, and the Naturalists' Field Club should be part and parcel of a Biological Society, aiding and deriving benefit from the union, there is, I am sure, no doubt either among them or among us. The Palæontologists are biologists; we could therefore find close bonds of union with the Geological Society, the Geologists' Association, and the Historic Society of Lancashire and Cheshire. As expounders of the ways and habits of the highest of the Primates, that Society can find its whole aims included in a Biological Society. Such an union of Biological Societies might receive the name of the *Liverpool Biological Institute*, and its volume of Proceedings might be arranged as is done at present by the New Zealand Institute. This, the great scientific society of that colony, consists of numerous "Philosophical Societies" meeting in far distant centres all over the colony, Dunedin, Christchurch, Nelson, Wellington and elsewhere. The subscriptions go to a central fund in Wellington, whither the various papers are sent, and after passing an editorial committee, are published in one yearly volume under their different subjects, zoology and anthropology, botany, geology, and miscellaneous or literary subjects each together. It is possible in this way to publish fully, and illustrate adequately, the various papers contributed to science in that colony. Some such scheme seems to me of urgent importance at the present time in Liverpool to economise our resources, to save reduplication of our scientific labours, and obtain for them adequate dissemination and recognition and the object of these disjointed inaugural observations is, if possible, to urge this much needed coalition of our forces into a powerful and influential society, which would exercise a predominant influence on Biological Science in Liverpool.

Yesterday while mentioning to Professor Herdman the subject of my address and the suggestions I intended to lay before you, he produced from a drawer a bundle of papers which showed me that he had forestalled them by ten years. His hope at that time was to see all the Scientific Societies united into one, meeting at the Royal Institution, with one fund, one conjoint publication and one library—not several libraries, as now, reduplicating some of their serials, and neglecting others—where the members could read comfortably and meet each other and their scientific friends.

Notwithstanding that my scheme has been forestalled I need not say that it gave me great pleasure to find that I should to-night have one able supporter in these suggestions. I had dared to urge a union of the Biological Societies only; but I should only too heartily welcome the larger scheme of Professor Herdman, and I venture to commend it anew to the Presidents and Councils of all the Scientific Societies in Liverpool, in the earnest hope that before the close of the century, we may witness, if not, a Royal Society of Liverpool, as I see no reason why we should not, at least, a *Liverpool Biological Institute*, with a reputation worthy of this University city, and second to none in the kingdom for the wide scope, originality and thoroughness of its contributions to science.

TENTH ANNUAL REPORT of the LIVERPOOL MARINE BIOLOGY COMMITTEE and their BIOLOGICAL STATION at PORT ERIN.

By W. A. HERDMAN, D.Sc., F.R.S.,

DERBY PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL ;
CHAIRMAN OF THE LIVERPOOL MARINE BIOLOGY COMMITTEE,
AND DIRECTOR OF THE PORT ERIN STATION.

[Read December 11th, 1896.]

AMONG the events of the past year which should be specially mentioned are 1°, the visit of the British Association, which involved a dredging expedition in Liverpool Bay, and an excursion of several days duration to Port Erin at the conclusion of the Liverpool meeting ; and 2°, the compilation of an index list of all the species of marine animals and plants recorded by the L.M.B.C. during the first ten years of their work.

The Station at Port Erin has been made use of by various members of the Committee and other naturalists for varying periods during the year ; the tanks in the aquarium have also enabled some experiments in sea-fish hatching to be carried out for the Lancashire Sea-Fisheries Committee ; and several students from both Owens College, Manchester, and University College, Liverpool, have occupied work-tables in the laboratory during the Easter, Whitsuntide, and Summer vacations.

STATION RECORD.

The following naturalists have worked at the Port Erin Laboratory during the past year :—

DATE.	NAME.	WORK.
<i>February.</i>	Mr. I. C. Thompson, Liverpool ...	Copepoda.
—	Prof. W. A. Herdman, Liverpool ...	Collecting.
<i>March.</i>	Mr. R. A. Dawson, Preston }	Sea-Fisheries.
—	Mr. Andrew Scott, Liverpool }	

<i>March.</i>	Prof. W. A. Herdman, Liverpool	...	Tunicata.
—	Mr. I. C. Thompson, Liverpool	...	Copepoda.
—	Mr. Charles E. Jones, Liverpool	...	Algæ.
—	Mr. A. H. Burt, Manchester	...	Algæ.
<i>April.</i>	Prof. F. E. Weiss, Manchester	...	Diatoms.
—	Mr. Charles E. Jones, Liverpool	...	Algæ.
—	Mr. A. H. Burt, Manchester	...	Algæ.
—	Prof. W. A. Herdman, Liverpool	...	Tunicata.
—	Mr. E. T. Browne, London	...	Medusæ.
—	Mr. Arnold T. Watson, Sheffield	...	Annelids.
—	Mr. F. W. Gamble, Manchester	...	Turbellaria.
—	Mr. J. A. Clubb, Liverpool	...	Collecting.
—	Prof. Gustave Gilson, Louvain	...	Annelids.
—	Mr. P. M. C. Kermode, Ramsey	...	General.
—	Mr. Harold Murray, Manchester	...	Collecting.
—	Mr. Terry, Manchester	...	Geology.
—	Mr. E. J. W. Harvey, Liverpool	...	Studying Fauna.
—	Mr. A. O. Walker, Colwyn Bay	...	Amphipoda.
—	Mr. R. A. Dawson, Preston	}	Sea-Fish Hatching.
—	Mr. R. L. Ascroft, Lytham		
—	Mr. Andrew Scott, Liverpool		
—	Miss L. R. Thornely, Liverpool	...	Polyzoa.
—	Mr. I. C. Thompson, Liverpool	...	Copepoda.
<i>May.</i>	Mr. E. T. Browne, London	...	Medusæ.
—	Mr. Andrew Scott, Liverpool	...	Fish.
—	Mr. W. Narramore, Liverpool	...	General.
<i>June.</i>	Rev. T. S. Lea, Liverpool	...	Algæ, &c.
<i>July.</i>	Mr. A. Derryhouse, Liverpool	...	General.
—	Rev. T. S. Lea, Liverpool	...	Algæ, &c.
—	Prof. W. A. Herdman, Liverpool	...	General.
—	Mr. A. Chopin, Manchester	...	Actiniaria.
<i>August.</i>	Mr. J. H. Ashworth, Manchester	...	Annelids.
—	Prof. W. A. Herdman, Liverpool	...	Tunicata.
—	Mr. W. Wadsworth, Manchester	...	General.
—	Prof. R. Boyce, Liverpool	...	General.
—	Miss L. R. Thornely, Liverpool	...	Polyzoa.
—	Mr. J. W. Woodall, Scarborough	...	General.
<i>September.</i>	Mr. H. C. Chadwick, Bootle	...	Echinoderms.
—	Prof. W. A. Herdman, Liverpool	...	Tunicata.
—	Mr. I. C. Thompson, Liverpool	...	Copepoda.
—	Mr. Alfred Leicester, Kent	...	Mollusca.
—	Prof. E. B. Poulton, Oxford	...	General.

<i>September.</i>	Dr. Johan Hjort, Christiania	...	...	Ascidians.
—	Dr. J. G. de Man, Ierseke	...	...	General.
—	Dr. J. F. Gilchrist, Cape Town	...	...	General.
—	Mr. Conrad Cooke, London	...	...	General.
—	Mr. Bedford, Cambridge	...	...	General.
—	Prof. Magnus, Berlin	}	...	Alge.
—	Prof. Pfitzer, Heidelberg			
—	Prof. Chodat, Geneva			
—	Prof. Weiss, Manchester			
—	Prof. Zacharias, Hamburg			
<i>October.</i>	Mr. Herbertson, Edinburgh	...	...	General.
<i>November.</i>	Mr. I. C. Thompson, Liverpool	...	...	Copepoda.
—	Professor W. A. Herdman, Liverpool	...	...	Tunicata.

In addition to these, a number of other members of the British Association party visited the Station between September 24th and 28th, including the Lieutenant Governor (Lord Henniker), Sir James Gell, Dr. Munro, Dr. Montelius, Professor Haddon, and others.

This list shows an increase in the number of workers. It is also satisfactory in containing the names of several senior students preparing for science degrees in Victoria University. The Councils of both the Owens College, Manchester, and University College, Liverpool, have arranged with the L.M.B.C. to engage by the year a "table" or work-place each in the Laboratory, to be constantly at the disposal of any members of the Biological departments of the Colleges—either staff or senior students—who may be nominated by the Professors. The "tables" in question have been labelled with the names of their respective Colleges, and the Committee sincerely hope that a succession of students will occupy these places and take advantage of the opportunity thus afforded them of becoming acquainted with marine animals and plants in their native haunts. The very perfection of modern Laboratory methods in our Colleges renders it the more necessary that all students of natural

science should, during some part of their course, study a living Fauna and Flora so as to realise the natural appearance, mode of occurrence and environment of the forms which they know otherwise only from books, lectures, and preserved specimens.

The Committee of the Liverpool Free Public Museum has also become a subscriber to the Station in order that one or other of the officials of the museum may have the use of a work place in the Laboratory during the period of weeks covered by the annual subscription. Other public bodies, or local scientific societies are invited to become subscribers in a similar manner (see Regulations, p. 49).

THE AQUARIUM.

Over 300 visitors paid 3d. for admission to the aquarium during the summer when it was on exhibition, and many other visitors, including members of the Isle of Man Natural History and Antiquarian Society, and of the British Association party who visited the island in September were taken round the establishment. The usual animals, including most of the common invertebrates of the shore and shallow water, and a few fishes, have been on exhibition. Some of the commonest forms, such as the sea-anemones, the hermit crabs, shrimps and prawns, and the flat-fish, are those that are most admired and excite most interest. People, as a rule, are pleased to see something they can recognise, and like to be told or shown something new about an old friend.

Our visitors to the Aquarium have ranged from the Governor (Lord Henniker) and his party to the fisher lads of the neighbourhood and the "trippers" from the inland towns of Lancashire and Yorkshire. We hear many curious remarks, and extraordinary opinions, in regard to the lower living things in the sea, when we take visitors

round the Aquarium. It is remarkable how prevalent the idea still is, even amongst people with some education, that sea-anemones, medusæ, and sponges are not living things, but are merely "growths" as they express it; and I have more than once, when talking about some well known fish which was swimming before us in the tank, been interrupted with the incredulous—almost indignant—exclamation, "But a fish is not an animal—is it?" Some are incredulous in regard to the real life-histories and habits we tell them of, or show them; others are extraordinarily credulous as to impossible stories they "have heard" of our doings on dredging expeditions. The boatmen of the neighbourhood apparently regale the summer visitors with sensational accounts of the wonders we find in the deep sea. A party of ladies and children came to the Aquarium on one occasion, and after looking anxiously round the tanks said, "But where are the pigmy elephants? We were told that you had dredged up some sea-elephants three inches long with tusks and trunk complete." Whether this was a highly-coloured version of our having found some large living specimens of *Dentalium*, the so-called "tusk shell" or "elephants' tooth shell," or was wholly imaginary, we failed to discover.

Children are usually much interested in our tanks, and with a little encouragement and help become keen collectors and quick observers. We have had many specimens of anemones, crabs, worms, and small fish brought to us from the rock-pools by boys and girls, who then take an additional interest in the tank or dish they have helped to stock, and bring their companions to see "the ones I caught." If we are able by some little experiment, or some observations, to demonstrate to them from their own specimens a fact in Natural History or an

example of some principle of Biology, not only does it add to their gratification but I am sure has considerable educational influence by opening their minds to new realms of thought, new methods of questioning nature.

For example, if a boy brings us a light-coloured shanny caught in a shallow exposed pool, we can place the little fish in a deep vessel in semi-darkness under a table, or cover it with some brown sea-weed, the result being that when the boy comes next day to look for his specimen, he has been known to exclaim, "Hullo! where is my shanny? There is only a black one here." It is then easy, by putting the fish into a shallow white dish in the bright sunlight, in a short time to turn the black shanny into what he recognises as the light-coloured one he caught. You can then tell him of the beautiful pigment cells of the skin and show them to him under the microscope in a small living fish, in a watch-glass full of seawater. You can show him a speckled shrimp hiding in sand and a mottled shrimp in gravel, and the little prawn *Virbius* which may be almost any colour according as you change its surroundings from green to red or to dark brown sea-weeds. You explain the difference in pigmentation on the upper and lower sides of a flat fish, you remind him of the Chamæleon, tell of Sir Joseph Lister's observations on the change of colour in the skin of the Frog, and—most beautiful experiment of all—show him the "blushing" of the newly-born cuttle-fish. From this there opens up a wide range of physiology, of the influence of light and the controlling action of nerves, not to mention natural selection and evolution in general.

This is only one of many examples that might be taken. Almost any of the common marine animals, if carefully watched as to structure and habits, show us interesting cases of adaptation to their surroundings and mode of life.

We are often asked about the sea-anemones of Port Erin. It may be useful to give here a list of the different kinds we have found round the southern end of the Isle of Man, between Fleshwick Bay and Port St. Mary. One of the best places to collect anemones is the Calf Sound, especially on the group of rocks called "The Cletts," at low water. Mr. A. Chopin, of Manchester, has kindly given me some additions to the list. I give first the correct modern* name of each species, then after each is placed in brackets the name used by Gosse in the "Actinologia Britannica," the book generally consulted, or any other name that has been much employed, and finally is given in each case the English name used by Gosse and other writers.

SEA-ANEMONES (ACTINIARIA) OF PORT ERIN.

Family I. PROTANTHIDÆ.

Corynactis viridis, Allm. (do. Gosse)—The Globehorn.

Capnea sanguinea, Forb. (do.)—The Crock.

Family II. HEXACTINIDÆ.

Halcampa chrysanthellum, Peach (do.)—the Sand Pintlet.

Anemonia sulcata, Penn. (*Anthea cereus*)—the Opelet.

Actinia equina, Linn. (*A. mesembryanthemum*)—the Beadlet.

Bunodes verrucosa, Penn. (*B. gemmacea*)—the Gemlet.

Urticina crassicornis, Müll. (*Tealia crassicornis*)—The Dahlia Wartlet, or Crass.

Sagartia miniata, Gosse (*Heliactis miniata*)—the Scarlet-fringed Anemone.

Sagartia venusta, Gosse (*Heliactis venusta*)—the Orange-disked Anemone.

* Professor Haddon has kindly revised the nomenclature and classification.

Sagartia nivia, Gosse (*Heliactis nivea*)—the Snowy Anemone.

Sagartia rosea, Gosse (*Heliactis rosea*)—the Rosy Anemone.

Sagartia sphyrodeta, Gosse (*Sagartia sphyrodeta*)—the Sandalled Anemone.

Sagartia lacerata, Dall. (? not distinguished by Gosse).

Cylista viduata, Müll. (*Sagartia viduata*)—the Snake-locked Anemone.

Cylista undata, Müll. (*Sagartia troglodytes*)—the Cave-dwelling Anemone.

Cereus pedunculatus, Penn. (*Sagartia bellis*)—the Daisy Anemone.

Adamsia palliata, Boh. (*Adamsia palliata*)—the Cloak Anemone.

Metridium dianthus, Ellis (*Actinoloba dianthus*)—the Plumose Anemone.

Paraphellia expansa, Hadd. (not known to Gosse).

FAMILY III. ZOANTHIDÆ.

Epizoanthus arenaceus, D. Ch. (*Zoanthus couchii*)—the Sandy Creeplet.

FAMILY IV. CERIANTHIDÆ.

Cerianthus lloydii, Gosse (do.)—the Vestlet.

Of many of these species several marked varieties occur.

SEA-FISH HATCHING.

In several previous reports we have discussed the suitability of the Port Erin Biological Station as a hatching establishment for sea-fish. No public body seems willing to move in the matter to the extent of erecting the necessary building and plant; but, with the help of a

small grant to fit up temporary wooden tanks, we undertook, during the last hatching season (Easter 1896), a series of experiments for the Lancashire Sea-Fisheries Committee. As the result of these experiments we successfully fertilised the eggs (obtained from the parent fish caught with the trawl) of the grey Gurnard (*Trigla gurnardus*), the lemon Sole (*Pleuronectes microcephalus*), and the Witch (*Pleuronectes cynoglossus*), and kept them in the tanks until they hatched out as young larvæ. We were not prepared in this first season to proceed with the rearing; but we propose, with additional tanks and an improved circulation of water, to carry the experiments a stage further next year.

Last spring we fitted up, in the lower floor of the Aquarium house, three wooden hatching tanks, each 5 ft. by 3 ft. by 1 ft., and so arranged like steps that water could flow by bamboo spouts covered with a fine silk net through the series of tanks. From the lowest wooden tank the water fell into the concrete floor tank, into which dipped an endless chain formed of an india-rubber belt bearing numerous little buckets. This chain of buckets revolved on a drum, octagonal in section, which was kept in motion by india-rubber belting passing from its axle to a pulley on a large water wheel actuated by the fresh water tap.*

Consequently, by turning the tap the whole apparatus was set in motion, and the sea-water from the concrete floor tank was raised by the little buckets and emptied into a sloping wooden trough which guided it to the upper hatching tank. Thus the same water was used over again,

* The tanks and the water motor apparatus were made most carefully and ingeniously, from my plans, by Mr. R. Garner, superintendent of the wood-working department at University College, Liverpool.

a couple of gallons of fresh sea-water being added to the system every day.

During the period when the apparatus was working the temperature and the specific gravity of the water in the tanks kept fairly constant, the extremes of the range being :—

Temperature from 50° to 53° F., and

Specific gravity from 0·0265 to 0·0270.

Each of the three tanks had a partition 1 foot from its outflow end which stopped 2 inches from the top, and a second partition 6 inches nearer the end, which reached the top but stopped short 2 inches from the bottom of the tank. In the two compartments imperfectly separated by this last partition, clean washed sand was placed so as to reach to about 4 inches from the bottom. Consequently all water escaping from the tank had to flow over the first partition and *under* the second, filtering through the bed of sand as it went. The object of this was to form a sand trap which would let the water pass through, but keep back the suspended fish eggs and embryos. By this method the same water can be used to circulate through several tanks containing different kinds of embryos.

A more detailed account of these fish-hatching experiments at Port Erin will be given in the Annual Report of the Sea-Fisheries Laboratory to the Lancashire Committee.

DREDGING EXPEDITIONS.

Since the last report, the Committee have organised eight dredging expeditions, nearly all in steamers, as follows :—

I. November 24, 1895.—Small boats. Localities dredged :—Port Erin Bay, in depths up to 7 fathoms.

II. February 2, 1896.—Hired steamer 'Rose Ann.'

Localities dredged and trawled:—Through the Calf Sound, and off its eastern and western ends, at depths of 16 to 20 fathoms.

III. March 14, 1896.—Sea-Fisheries steamer ‘John Fell.’ Off Port Erin.

IV. April 5, 1896.—Hired steamer ‘Rose Ann.’ Localities trawled:—Out in the deep channel, 12 miles S.W. of Calf; bottom reamy mud, with many spawning fish; depths 40 to 50 fathoms.

V. April 21-24, 1896.—Sea-Fisheries steamer ‘John Fell.’ Localities trawled:—Deep channel, 12 miles S.W. of Calf, and further north to opposite Port Erin; also west of Dalby, 8 miles off; reamy bottom; depths 20 to 40 fathoms.

VI. May 29 and 30, 1896.—Sea-Fisheries steamer ‘John Fell.’ Localities:—Estuary of the Wyre and around Piel Island, in Barrow Channel; shallow water.

VII. August 31, 1896.—Mr. Woodall’s S.Y. ‘Vallota.’ Localities dredged and trawled:—Between Port Erin and Calf Island; depth 17 to 22 fathoms.

VIII. September 19, 1896.—Sea-Fisheries steamer ‘John Fell.’ Localities:—Liverpool Bay, Hilbre Swash and the Rock Channel; 4 to 10 fathoms.

Two of these expeditions—those at Easter in the ‘Rose Ann,’ and at the end of April in the ‘John Fell’—were particularly successful, and resulted in the capture of a number of new and interesting species. Amongst these is a large green Gephyrean worm, which is either *Thalassema gigas*, M. Müller, or a new species of *Thalassema* with a remarkable pigment (see p. 25); and a Cumacean, for which a new genus is necessary.

Additions have been made during the year to most of the groups of invertebrate animals, and these will be found noted in the lists below; in addition Mr. A. O. Walker

has prepared the following special account of the higher Crustacea obtained on these expeditions:—

CRUSTACEA.

The following species of MALACOSTRACA have been added to the fauna since the last report. Nearly all were dredged off the S. end of the Isle of Man in the 'John Fell' expedition, from April 22 to 24, 1896.

PODOPHTHALMA:—*Portunus corrugatus* (Pennant).—S.E. of Calf Sound, 26 fathoms.

Nika edulis, Risso.—Co. Down Coast (Ascroft); and from stomach of whiting, 12 m. S.W. of Chicken Rock, 33 fathoms.

SCHIZOPODA:—*Erythrops serrata*, G. O. Sars; 12 m. S.W. of Chicken Rock, 33 fathoms.

Siriella armata (M. Edw.). Port Erin harbour, April.

CUMACEA:—Family Leuconidæ—*Leuconopsis*, n. gen.

Female with a distinct two-jointed appendage to the fourth pair of feet, not furnished with natatory setæ. Lower antennæ short, with the third joint conical, with a minute one-jointed rudimentary flagellum. Rami of uropoda subequal.

Male with the third pair of feet each provided on the second joint with a pair of curved blade-like processes.

Remaining characters as in *Leucon*.

Leuconopsis ensifer, n. sp.

Female:—Carapace about as long as the free thoracic segments, dorsal crest of fourteen teeth beginning about the middle of the upper margin, and curving down to the base of the rostrum; a small tooth on the upper and near the posterior margin; lower margin with the anterior half coarsely toothed, and forming with the anterior margin an acute angle the upper portion of which is finely toothed. Rostrum about quarter the length of

the carapace, obliquely truncate; almost horizontal; lower margin with two or three teeth near the extremity and two or three near the base.

Fourth pair of legs with an exopodite or imperfect natatory appendage, two-jointed, reaching nearly to the end of the first joint, which is almost as long as the remaining four.

Telson triangular, as in *Leucon*.

Uropoda with peduncle and both rami subequal in length; peduncle almost spineless, inner ramus with six unequal spines on the inner and two on the outer side of the first joint; second joint with two very short and slender spines on the inside; outer ramus obliquely truncate, with five plumose setæ on the inner side and four at the end. Length $5\frac{1}{2}$ mm.

Male:—Upper margin of carapace as long as the free segments; lower margin with five or six teeth on the anterior half increasing in size anteriorly, forming a right angle with the anterior margin which has five teeth just below the rostrum, the second from the rostrum being the largest; rostrum horizontal, blunt, about one-sixth the length of the carapace, with five small teeth on the lower margin.

First pair of legs with seven teeth on the lower margin of the first joint. Second pair with a large spine at the distal end of the second, and two unequally long spines at the end of the third joint. Third pair with an appendage on the second joint, consisting of two parallel curved blades, twice as long as the succeeding three joints. Length $8\frac{1}{2}$ mm.

The above interesting species has a general resemblance to *Leucon*, from which genus, however, it may be at once distinguished by the appendages on the fourth pair of legs in the female and the third pair in the male. It was

taken in the tow net attached to the back of the trawl net on April 22, 12 m. S.W. of Chicken Rock, 33 fathoms.

Eudorella emarginata (Kröyer).—One female. Same locality as last.

Campylaspis glabra, G. O. Sars.—Three specimens, from same locality as last. A Mediterranean species, not previously recorded from British Seas. I have specimens taken by Mr. Ascroft off the Ile d'Yeu.

AMPHIPODA :—*Normanion quadrimanus* (Bate and Westwood).—One small specimen ; length 2 mm., 6 miles W.S.W. of Calf, 23 fathoms.

Stenothoë crassicornis; n. sp.

Three males. Same locality as last.

Mandibles without a palp.

Maxillipedes with the basal lobe very small, divided to its base.

Antennæ stout, the flagellum of the lower but little longer than the last joint of the peduncle ; its first joint almost as long as the remaining four together.

First gnathopods as in *S. marina*.

Second gnathopods with the palm of the propodos defined near the base by a triangular tooth, the distal extremity expanded and cut into four blunt lobes, of which the proximal is much the largest ; dactylus with a prominence on the inner margin, coinciding with the palmar lobus.

Peræopods short and strong, the third (meros) joint in the last three pairs much produced backwards, as in *Probolium calcaratum*, G. O. Sars.

Third uropods with four spines on the upper surface of the peduncle, which is twice as long as the first joint of the ramus.

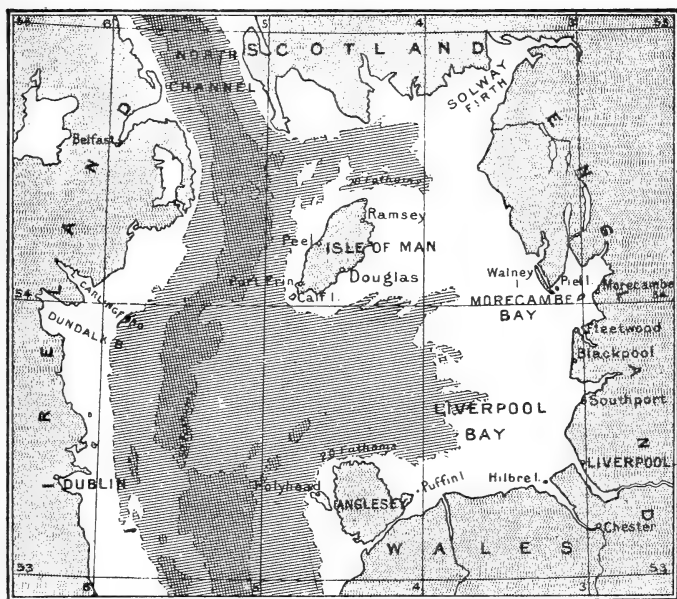
Telson with three pairs of dorsal spines on its proximal half, the first pair the smallest. Length 2 mm.

In the form of the hand of the second gnathopods this species approaches *S. tenella*, G. O. S., and *S. dollfusi*, Chevreux; but both these (perhaps identical) species are remarkable for the length and slenderness of their antennæ and peræopods.

Halimemon parvimanus, Sp. Bate.—Five or six specimens, 12 m. S.W. of Chicken Rock, 33 fathoms.

Argissa hamatipes (Norman) = *Syrrhoë hamatipes*, Norman, 'Brit. Ass. Rep.', 1868 (1869). p. 279. Same locality as last.—Two females, one with ova, 2 mm. long.

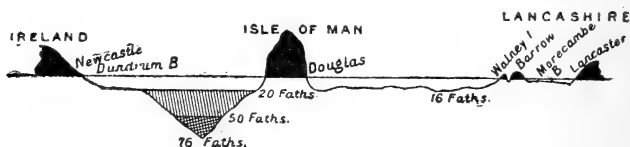
FIG. 1.—Plan of the L.M.B.C. District.



Prof. G. O. Sars, with some hesitation, follows Boeck in placing *Argissa* among the Pontoporeiidæ, but there can be little doubt that Canon A. M. Norman was right in classing it with the Syrrhoidæ.

Gammarus campylops, Leach.—Brackish pond near Colwyn Bay; also Port Erin harbour.

FIG. 2.—Section across the Irish Sea through Douglas.



OTHER ADDITIONS TO THE FAUNA.

In making a thorough revisal of our lists of the Local Fauna and Flora for the purpose of presenting a complete report to the British Association at the recent Liverpool meeting, it was found that some species we had discovered in the past had escaped record, a few others had been recorded under names that have now been superseded, while a considerable number of previously unknown forms have turned up as the result of the year's work. It was stated in the British Association Report that all these species would be duly recorded, with their localities, in this the Tenth Annual Report. They are as follows* :—

FORAMINIFERA :—*Hyperammia arborescens*, Norm., off Peel, Isle of Man.

Gypsina vesicularis, P. & J., off the Isle of Man.

COELENTERATA :—*Coryne vaginata*, Hincks, I. of Man S.

Corymorpha nutans, Sars, off Port Erin.

Hybocodon prolifer, Agassiz, off Port Erin.

Podocoryne carnea, Sars, off Port Erin.

Phialidium temporarium, Browne, off Port Erin.

* For these additional records we are indebted to a number of the Naturalists who are now working at the Fauna of the Irish Sea—especially to Dr. G. W. Chaster, Mr. I. C. Thompson, Mr. A. Leicester, Mr. E. T. Browne, Mr. A. O. Walker Miss L. R. Thornely, and Mr. Andrew Scott.

Tiaropsis multicirrata (Sars), off Port Erin.

Agalmopsis elegans, Sars, off Port Erin.

Virgularia mirabilis, Lamk., off the west of the Isle of Man, deep water.

VERMES :—*Planaria littoralis*, Van Ben., Port Erin.

Thalassema, sp. (? n. sp.), deep water off Port Erin.

Polynoe reticulata, Clap., this is recorded in Vol. III. of "Fauna," p. 136, as *P. extenuata*, Grube.

P. semisculpta, John. Recorded in Vol. III, p. 137, as *P. propinqua*, Mgrn.

Chaetopterus variopedatus, Ren. Recorded as *C. insignis*, Baird, in Vol. III., p. 158.

Arenicola ecaudata, John., Port Erin, &c.

Autolytus longisetosus (Orsted), Port Erin.

Flabelligera affinis, Mgrn., recorded in Vol. III., p. 159, as *Siphonostoma diplochaitos*, Otto.

POLYZOA :—*Membranipora spinifera*, Johnst., off Garwick Head, and off South Coast, Isle of Man.

Schizoporella alderi, Busk, off the West Coast of the Isle of Man.

Smittia cheilostoma, Manz., on shells, dredged off the Calf of Man.

Cylindracium giganteum, Busk, Puffin Island.

Loxosoma phascolosomatum, Vogt, on *Phascolosoma vulgare*, from near Puffin Island.

CRUSTACEA :—*Portunus corrugatus* (Penn.), S.E. Calf Sound, 26 faths.

Nika edulis, Risso, Co. Down Coast, 12 m. S.S.W. of Chicken Rock, in whiting's stomach.

Erythrops serrata, G. O. Sars, 12 m. S.W. of Chicken Rock, 33 faths.

Siriella armata (M. Edw.), Port Erin Harbour, April.

Nebalia bipes, (M. Edw.), 12 m. S.W. of Chicken Rock, 33 faths.

Leuconopsis ensifer, A. O. Walker, 12 m. S.W. of Chicken Rock, 33 faths. (new genus—see p. 14).

Eudorella emarginata, (Kröyer), 12 m. S.W. of Chicken Rock, 33 faths.

Campylaspis glabra, G. O. Sars, 12 m. S.W. of Chicken Rock, 33 faths.

Normanion quadrimanus (Bate & Westwood), 6 m. W.S.W. of Calf, 23 fathoms.

Stenothoe crassicornis, A. O. Walker, same locality.

Halimemon parvimanus, Sp. Bate, 12 m. S.W. of Chicken Rock.

Argissa hamatipes (Norman), same locality.

Gammarus campylops, Leach, brackish Pond, near Colwyn Bay; and Port Erin Harbour.

OSTRACODA:—(?) *Argillæcia cylindrica*, Sars, off Peel, Isle of Man, 50 faths.

Bairdia acanthigera, Brady, off Southport, 25 faths.

Cythere albomaculata, Baird, Southport, and Port St. Mary.

C. globulifera, Brady, near Nelson buoy, off Ribble, 14 faths.

C. lutea, O. F. M., in *Laminaria*, Port St. Mary.

C. robertsoni, Brady, Southport shore.

Eucythere declivis, Norman, off Peel, 50 faths.; and Nelson buoy, 14 faths.

Cytherura nigrescens, Baird, Roosebeck Mussel Bed.

C. acuticostata, Sars, Southport, and Nelson buoy, 14 faths.

Cytheropteron punctatum, Brady, off Peel, 50 faths.

Paradoxostoma flexuosum, Brady, Roosebeck Mussel Bed.

Cytheridea elongata, Brady, Morecambe Mussel Beds.

C. torosa, Jones, Nelson buoy, 14 faths.

Cytherideis subulata, Brady, Roosebeck Mussel Bed.

Bythocythere simplex, Norman, off Peel, 50 faths.

COPEPODA :—*Scolecithrix hibernica*, A. Scott, between

Isle of Man and Ireland, off County Down Coast.

Centropages typicus, Kröyer, off Port Erin.

Pseudocyclops crassiremis, Brady, in Neritic material,
off Spanish Head.

P. obtusatus, Brady and Rob., in Neritic material, off
Spanish Head.

Lamippi proteus, Clap., from *Alcyonium digitatum*,
off Peel, Isle of Man.

L. forbesi, T. Scott, from *Alcyonium digitatum*,
trawled off Peel, Isle of Man.

Stenhelia herdmani, A. Scott, in Neritic material, off
Spanish Head.

Stenhelia similis, A. Scott, in Neritic material, off
Spanish Head.

Canthocamptus palustris, Brady, Ainsdale Mussel Bed.

Tetragoniceps trispinosus, A. Scott, in Neritic mater-
ial, off Spanish Head.

Laophontodes bicornis, A. Scott, in Neritic material,
off Spanish Head.

Thalestris forficuloides, T. and A. Scott, off Port Erin.

Pseudothalestris major, T. and A. Scott, off Port Erin.

Idya elongata, A. Scott, Morecambe Mussel Beds.

Parartotrogus richardi, T. and A. Scott, off Peel,
amongst refuse.

Collocheres elegans, A. Scott, off Port Erin.

Chondracanthus merlucci, Holt, from Hake, caught
off Calf of Man.

Lerneonema spratta, Sow., from Sprats caught in the
Mersey.

Lerneopoda galei, Kr., from dogfish caught in Menai
Straits,

PYCNOGONIDA :—*Nymphon rubrum*, Hodge, Turbot Hole,
 Puffin Island.

MOLLUSCA :—*Mytilus phaseolinus*, Phil., Isle of Man, S.

Leda minuta, Müll., var. *brevirostris*, Jeff., Port Erin.

Mactra solida, var. *truncata*, Mont., Puffin Island.

Mactra subtruncata, var. *striata*, Brown, Southport.

„ var. *inæqualis*, Jeff., Southport.

Saxicava rugosa, var. *arctica*, L., Isle of Man South.

Panopea plicata, Mont., Southport.

Teredo megotara, Han., and var. *mionota*, Southport.

T. norvegica, Speng., var. *divaricata*, Desh., South-
 port.

Siphonodentalium lofotense, Sars, off Peel, I. of Man.

Trochus zizyphinus, var. *humilior*, Jeff., Port Erin.

Emarginula fissura, var. *elata*, Jeff., central area.

Rissoa striatula, Mont., Waterloo.

R. zetlandica, Mont., Isle of Man, South.

R. striata, var. *arctica*, Lov., Puffin Island, Port
 Erin, and Port St. Mary.

„ var. *distorta*, Mar., Puffin Island.

Hydrobia ventrosa, Mont., Colwyn Bay and South-
 port.

Odostomia minima, Jeff., Isle of Man South; and
 Puffin Island.

O. clavula, Lov., Southport.

O. rissoides, var. *glabrata*, off Port Erin.

O. albella, Lov., Port St. Mary.

„ var. *subcylindrica*, Marsh., Port Erin.

O. insculpta, Mont., Puffin Island, Southport and
 Isle of Man South.

O. turrita, var. *nana*, Jeff., Port Erin.

O. interstincta, var. *suturalis*, Phil., Southport, Puffin
 Island, and Isle of Man.

Cerithium perversum, L., Isle of Man South.

Buccinum undatum, L., var. *littoralis*, King,
Southport.

„ var. *jordoni*, Chaster (MS.),
Southport.

„ monstr. *acuminatum*, Brod.,
Southport.

Trophon truncatus, Str., var. *alba*, Jeff., Port Erin.

Fusus propinquus, Ald., var. *jeffresiana*, Fisch. (see
Fauna, vol. I., p. 244).

F. antiquus, L., var. *alba*, Jeff., Isle of Man South.

F. gracilis, Da C., var. *convoluta*, Jeff., Port Erin.

Defrancia linearis, Mont., and var. *æqualis*, Jeff.,
Isle of Man.

Pleurotoma attenuata, Mont., Isle of Man South.

Utriculus truncatulus, var. *pellucida*, Bro., Puffin I.

U. mammillatus, Phil., Isle of Man South.

Philine catena, Mont., Isle of Man South.

Melampus bidentatus, var. *alba*, Turt., Isle of Man S.

TUNICATA :—*Fritillaria*, sp., Port Erin.

CEPHALOCORDA :—*Branchiostoma lanceolatum*, Pall.

PISCES :—*Zeugopterus norvegicus*, Gunth., S.W. of Chicken
Rock.

MAMMALIA :—*Phoca vitulina*, Linn., Mersey.

Balænoptera musculus, Linn., North Coast of Wales.

OTHER INVESTIGATIONS.

The Rev. T. S. Lea has been continuing his observations on the distribution of the species of sea-weeds and associated animals on the shore at Port Erin. He has produced a very beautiful series of photographs which were exhibited in the Loan Museum at the British Association Meeting, and were also shown as lantern slides to section D. at one of the forenoon sittings. Besides photographs of Algæ, natural size, *in situ*, and as

microscopic objects, Mr. Lea has a number of views into rock pools, taken with his vertical camera, showing anemones fully expanded and fish lying on variously coloured floors. Some of the foreign Biologists were much pleased with these photographs, and Mr. Lea has supplied Prof. Chodat with a number of reproductions of the lantern slides for use in lectures at the University of Geneva. Mr. Lea has kindly presented the complete series of his photographs as lantern slides to the New Museum of Zoology at University College, where they will be permanently on exhibition, classified and labelled, so as to illustrate the littoral fauna and flora at the south end of the Isle of Man.

The large green *Thalassema* of which several specimens, all more or less mutilated, were trawled from the deep water to the S.W. of Port Erin at Easter, seems to be an undescribed form. It must be, when perfect, about 20 cm. in length over all, and 10 or 12 mm. in average thickness. The extended proboscis measures about 10 cm. in length, and 15 to 20 mm. in breadth. In appearance it most nearly resembles *T. gigas*, M. Müller, but differs from that species in the relative proportions of body and proboscis, in the greater breadth of the proboscis, and in the shape of its extremity. The colour is a rich green. Prof. Lankester, who has seen one of the specimens, calls it a "beautiful chrome green," and says "it is exactly the colour of my specimen of *Hamingia*."

Our species differs from *Hamingia* (as defined by Lankester) in having strong setæ present at the genital pores in the female, and from *Bonellia* (another allied, green form) in the shape of the proboscis and other particulars. It is, in its anatomical characters, a member of the genus *Thalassema*, but differs in some points from all the known species. The ciliated funnels of the cloacal

nephridia are borne on branched twigs of a snow white colour given off by the dark brown central tube of the organ. There is only a single pair of anterior nephridia. These contain ova, but no rudimentary males were found. All our specimens are females. A full description, with figures, of this new species will be published shortly.

Prof. Sherrington and Dr. Noël Paton have independently investigated the green pigment spectroscopically. They report that it is a very remarkable and apparently unknown pigment which is not allied to hæmoglobin or chlorophyll. It is not a respiratory pigment and is apparently nearer to "bonellein," described by Dr. Sorby from the Gephyrean *Bonellia viridis*, than to any other known pigment, but differs markedly in some respects and cannot be identical with it. Prof. Sherrington gives the spectral characters as follows:—"The solution of the pigment in formol (5% solution) exhibited considerable absorption of the violet end of the spectrum (nearly as far as solar line F, to λ 468), less of the red end (to solar *a*, λ 716), and a single broad band of absorption in the red between C and D with its centre at λ 617 and extending from λ 602 to λ 630*. No other absorption band existed. Hæmoglobin in formol solution exhibits the spectrum of *reduced* hæmoglobin. There is no similarity between the spectrum of the pigment here examined and that of hæmoglobin. On the other hand the position of the band recalls that of the strong band given by bonellein λ 643 to λ 617 (Sorby). But bonellein was not examined in formol solution. No other definite absorption band was given by the *Thalassema* pigment in formol."

Mr. J. H. Ashworth, Demonstrator of Zoology at the Owens College, spent some weeks at Port Erin in August, and besides collecting, preserving, and examining various

* Dr. Noël Paton gives the centre of the band at λ 640.

marine forms devoted himself specially to the investigation of the Lug-worms, *Arenicola*. The following extract is from a letter written by Mr. Ashworth to the Hon. Director on leaving the Laboratory:—"During the last weeks I was engaged nearly all the time upon *Arenicola*. I took your advice and went over to Bay-ny-Carrickey last Monday, and in about one-and-a-half-hour's searching obtained five specimens of *Arenicola ecaudata*, and on Wednesday I went to the same place again and obtained about a dozen more. I have got the ova and sperms from them, the latter almost ripe, and I have made several dissections and find many points of difference between this species and *Arenicola piscatorum*. I intend to follow this work up after my return to College in October. I have enjoyed my visit to Port Erin very much, and have found the laboratory very convenient for work. I am greatly obliged to you for the many valuable suggestions and help you have given me while I have been there, and I thank you most sincerely for them."

Mr. Ashworth is preparing a paper on *Arenicola piscatorum* and *A. ecaudata*, which will be laid before the Liverpool Biological Society during the present session.

Professor Weiss reports that he investigated the Diatoms of the plankton during the month of April, with special reference to the variation in the preponderance of the various forms at different times. In this connection he observed the breaking-up of the protoplasm of *Chaetoceros* and *Coscinodiscus* into eight or sixteen nucleated masses within the parent frustule, as recently described by Mr. George Murray before the Linnean Society of London (June 18th). He also collected a large quantity of the Coralline Algæ, both shore and deep water forms, an account of which he is preparing for the Liverpool Biological Society.

Mr. Hiern, with the assistance of several other Botanists present at the Biological Station at the end of September, compiled a list of Manx plants which will appear shortly in the "Journal of Botany."

Dr. C. H. Hurst reports as follows in regard to some specimens of *Nymphon* dredged from the "Turbot hole," near Puffin Island:—

"There were 14 specimens:—

1 was a typical *N. gracile*.

3 were spiny *N. gracile*.

2 ,, *N. gracile*, but with *flat* ocular tubercle.

2 ,, *N. gracile*, but with the tarsus of *N. brevitarse*.

3 ,, young, and doubtfully *N. gracile*.

3 ,, recorded as *N. rubrum*—but *none were red*.

"The average species-monger would make *six* species of those 14 specimens out of one "hole." In spite of the decision of Sars that *N. gracile* and *N. "rubrum"* (which is *not* red) are distinct, I do not believe they are. Typical specimens of both were found as well as some specimens possessing some characters of *N. brevitarse*: but there were also found, *in the same hole*, other forms which bridge over the gap between the supposed species. The differences between the most extreme forms were less than those between individuals of *Bombus terrestris* (workers) found in a single nest and far less than the differences between *Araschnia (Vanessa) prorsa* and *A. levana*, which are now known to be a single species. The species (*N. gracile-rubrum-brevitarse*) may be a polymorphic species, but I believe it is *one* species and not three."

Mr. James Hornell has supplied the following notes as being supplementary to his Report on the Polychætaous Annelids of the L.M.B.C. District published in vol. iii. of the "Fauna" (and Trans. L'pool Biol. Soc., vol. v., p. 223).

“The following remarks are intended to bring the above Report up to the present date, so far as the writer (who has been absent from the district for several years) is able.

p. 233. *Polynoë extenuata*, here mentioned, should be referred to *P. reticulata*, Claparède.

p. 234. *Polynoë propinqua*, Mgrn. is the *Lepidonotus semisculptus* of Johnston's Brit. Museum Catalogue, and hence should appear now as *Polynoë semisculpta*.

p. 235. Undoubtedly the *P. floccosa* of Prof. M'Intosh's list is also a synonym for the last named species, *P. semisculpta*.

p. 255. Joyeux Lafaie (Archiv. d. Zool. Exp. (Ser. 2), viii., p. 244, 1890) shows that only one European species of *Chaetopterus* exists, viz., *C. variopedatus*, Ren., hence this name replaces that of *C. insignis*.

p. 256. The form here entered as *Siphonostoma diplochaïtos* has been shown by further investigation to be the *Flabelligera affinis* of Malmgren.

p. 248. Here is given a note on the embryology of *Arenicola* and of *Scoloplos*, and while the remarks relating to the latter have been found to require no correction, my experience on the Jersey Coast has brought up facts which show that an error was made as to the parent species of those larvæ described as belonging to *Arenicola*; hence this note must be corrected by the substitution of the name *Phyllodoce maculata* for that of *Arenicola*. With this alteration of name the description holds good. In the description of pl. xiv., figs. 12 to 21 refer therefore to the embryology of *Phyllodoce maculata*, and not to *Arenicola*.”

Since Mr. Hornell left Liverpool for Jersey three additional species of Polychæta have been added, viz., *Arenicola ecaudata*, Johnston, *Magelona papillicornis*, Müll., and *Autolytus longisetosus*, Örst.

Professor Boyce has continued his important investigations into the bacteriology of the oyster and its possible connection with disease in man. He has drawn up a report upon the subject which was read before the Liverpool Meeting of the British Association. As an account of the present state of the question, and a summary of Prof. Boyce's bacteriological work will be given, in a few weeks, in the Annual Report of the Lancashire Sea-Fisheries Laboratory, it is unnecessary to do more here than to state that the fresh experiments on inoculating Oysters with the typhoid Bacillus and keeping them under observation, both in stagnant and in running sea-water, show (1) that the typhoid organism does not multiply in the stomach or tissues of the Oyster, (2) that Oysters fresh from the sea contain fewer bacteria (chiefly the common colon bacillus) than those that have been stored or kept in shops, and (3) the power of the Oyster to get rid of bacterial infection when placed in a stream of running water, there being a great diminution or total disappearance of the *Bacillus typhosus* in from one to seven days.

Mr. Edward T. Browne has sent me the following notes on the species of Medusæ, and other constituents of the pelagic fauna, taken by him at Port Erin during his work there in April 1896 :—

“ This visit to Port Erin in April, 1896, was specially made to obtain more specimens of the interesting medusa *Hybocodon prolifer*, for the completion of my work on the development of its ova. This medusa was fairly plentiful in 1893, and very abundant in April 1894, but was unfortunately absent in 1896.

“ The pelagic fauna throughout the whole of April 1896. was conspicuously poor in medusæ and other pelagic animals usually found in the spring of the year. This

scarceness is difficult to account for, as the previous winter had been mild and the spring favourable for an early fauna.

"The temperature of the sea was 48°F. at the beginning of April, two degrees higher than in 1894, when the temperature did not reach 48° until 26th of April. The fauna, nevertheless, was more like that usually recorded for February than for April. Diatoms throughout the month were exceedingly abundant and aided by the gelatinous algæ quickly clogged the meshes of the tow-net. Often when the can at the end of the net was emptied into a glass bottle, the contents had the appearance of thick pea-soup, so great was the abundance of diatoms.

"The medusæ showed a decrease in the number of species compared with 1894, and a great decrease in quantity, especially in the case of *Margellium octopunctatum*, which swarmed in the Bay in 1894, but of which only four specimens were taken in 1896. Another noticeable feature was that all the medusæ, except *Obelia*, were young forms and usually belonged to the earliest free-swimming stage.

"The ctenophores usually plentiful in Port Erin Bay in the spring were entirely absent. A species of *Fritillaria* made its first appearance on 21st of April, and a single specimen of the larval *Magelona* on 29th of April.

"*Agalmopsis elegans*, Sars (recorded as *Halistemma*, sp.? Fauna, iv. p. 279), first taken in April 1894, did not make its appearance in 1896."

Mr. Browne will communicate this session to the Biological Society a revised list of the L.M.B.C. Medusæ.

The Committee have lately purchased from Mr. M. Treleaven Reade, the inventor, one of his folding "Shell-bend" boats for the use of the Biological Station,

Although workers at Port Erin will no doubt in the future, as in the past, make considerable use of the ordinary pleasure boats of the bay, still it frequently happens that one, two, or three desire to go out tow-netting, or collecting round the rocks or the break-water at low tide on occasions when it is inconvenient or impossible to hire a boat. Under these circumstances the "Shell-bend" will be most handy. It is a flat-bottomed dinghy 10 feet in length, with plenty of room for three men to work tow-nets and other collecting implements. When hauled ashore, the sides fold down on the bottom, and then one or two men can easily carry the boat for a considerable distance.

THE VISIT OF THE BRITISH ASSOCIATION.

At the conclusion of the Meeting in Liverpool last September, about 100 members of the British Association crossed to the Isle of Man for the purpose of spending five days in exploring the Natural History and Antiquities of the Island. The party broke up into four sections, of which two (the Archæologists and the Geologists) made their headquarters at Douglas, while the other two (Zoologists and Botanists) went on to Port Erin and lived at the Bellevue Hotel. The weather throughout the visit was very unsuitable for Biological work. The steam-trawler "Rose Ann" was in attendance, but it was impossible to go to sea in her, although attempts were made both from Port Erin and Port St. Mary. The time was spent in shore-collecting at various parts of the coast, and in searching for the rarer Algæ and encrusting animals amongst the banks of *Laminaria* and other coarser seaweeds cast ashore by the storm.

The foreign Botanists were much pleased with the marine flora, and several of the Zoologists were especially interested in the abundant supply of Compound Ascidians,

belonging to the genera *Botryllus*, *Botrylloides*, *Leptoclinum*, *Amaroucium* and *Diplosoma*, which were found attached to the stems and roots of the *Laminaria*. Dr. Johan Hjort was anxious to see the buds in the colonies of as many species as possible. He was also desirous of examining the stolons of *Clavelina*, of which specimens can usually be procured on the side walls of a deep shore pool near Spaldrick; and we were able to show him the hibernating condition of the buds in the stolons which Professor Giard has lately discussed,* and which have been known for some years at Port Erin. Several of the Zoologists and Botanists preserved and carried off collections, and Prof. Chodat since his return to Geneva has given two public lectures before his University on what he saw of the Marine Fauna and Flora of the Isle of Man during our Expedition.

THE BRITISH ASSOCIATION FUND.

The surplus of the Local Fund, collected for the purpose of meeting the expenses of the visit of the British Association to Liverpool, was, by a resolution of the Local Committee at their final meeting on November 30th, 1896, placed in the hands of trustees to be invested for the purpose of promoting the work of the Liverpool Marine Biology Committee. The view of the British Association Executive Committee in recommending this allocation of the fund, was that the money had been subscribed *locally* for the purposes of a meeting *for the Advancement of Science*, and that consequently the surplus should be devoted to some investigation which would result in the advancement of local science. In recommending the L.M.B.C. as a suitable body to receive the fund and carry on the researches, the Executive Com-

* Comptes-rendus, Aug. 3, 1896.

mittee drew up and circulated amongst the subscribers and the members of the Local Committee the following statement :—

“ Memorandum on Behalf of the Executive
Committee.”

“ In considering the best allocation for the surplus which the Treasurers are happily able to report, the Committee have sought to select the object which would most commend itself to Subscribers as *local*, as *representative*, and as *permanently conducive* to the great aim of the British Association, the Advancement of Science. After considering various suggestions, the Committee are unanimous in recommending that the fund should be entrusted to the Liverpool Marine Biology Committee for administration under trust.

“ The group of Sciences promoted by the Liverpool Marine Biology Committee includes those which most admit, and indeed require, local investigation.

“ Its composition is widely representative, combining members from Liverpool with representatives of North Lancashire, Manchester, North Wales, and the Isle of Man. It is intimately associated with the work of the Lancashire Sea-Fisheries Committee, so important to the industrial prosperity and development of Liverpool and the neighbourhood. It has, moreover, been remarkably successful in eliciting the enthusiasm and support of non-professional as well as professional workers in Science.

“ Its scope is comprehensive, and papers directly emanating from its action have been read before several different Sections of the British Association. Alike in quality and quantity, the work of the Committee

has done honour to Liverpool. The Annual Reports and the four published volumes of 'Fauna and Flora of Liverpool Bay' are notable contributions to Marine Biology; and altogether it has helped to inspire more than a hundred papers contributed to Scientific Journals. At its Laboratory, first at Puffin Island, now at Port Erin, laborious researches have been carried out, such as in other countries rest on State support, but in England are left to the public spirit and enterprise of individuals or communities.

"A small endowment of the kind contemplated will be invaluable for securing fruit and permanence to the activities of the Liverpool Marine Biology Committee. The publication of Proceedings, and the conduct of scientific investigations, make a continuous and heavy drain upon the resources of a voluntary society. A grant which has been allotted for the last four years to the Liverpool Marine Biology Committee from the funds of the British Association, expired with the present year, and the annual income from this endowment will at a fortunate moment make good the loss.

"The close association of the Liverpool Marine Biology Committee with two of the British Association Honorary Local Secretaries, whose exertions contributed so much to the success of the recent Meeting, is no mere coincidence. In connection with the Liverpool Marine Biology Committee, Prof. Herdman and Mr. Isaac Thompson established not only their enthusiasm for Science, but also their capacity and resource in organisation. By happy fortune the British Association Meeting, which owed so much to their energy, can make an apt return by permanently forwarding that local development of Science which they have most at heart."

The recommendation of the Executive Committee met with universal approval; and only 2 subscribers out of a total of 300 took advantage of the opportunity which was given to them of withdrawing their share of the surplus. The formal resolutions which were unanimously passed by the Local Committee on November 30th were:—

1°. “That the balance remaining after the settlement of all expenses connected with the Meeting of the Association be handed to Trustees, the income of the fund to be applied in or towards the publication of Scientific Proceedings and the prosecution of Scientific Research; the Trustees to pay such income to the Treasurer of the Liverpool Marine Biology Committee for the above purposes, and the receipt of such Treasurer shall be a sufficient discharge to the Trustees for such payment.”

2°. “That the Vice-Presidents, the Treasurers and the Secretaries be empowered to select Trustees, and to define and settle the exact terms of the Trust.”

At the subsequent meeting of these Local Officers, the Trust deed, drawn up by Mr. J. W. Alsop, was submitted and Mr. W. E. Willink, J.P., Mr. Charles Booth, Jun., and Professor Herdman were appointed Trustees.

The fund which amounts, after the payment of all expenses, to about £950 will be invested, and the annual proceeds will be available as a small fixed income for the advancement of our work.

The L.M.B.C. while gratefully accepting this welcome addition to their means, and while they appreciate highly this mark of confidence in their work, cannot but feel that they are accepting also increased responsibility. They have constantly in the past kept before them the view that

in undertaking to report upon the Marine Biology and Geology of the district, and in asking for subscriptions to defray the necessary expenses of the work, they were incurring responsibilities both to the scientific world and to the public of Liverpool. They have been responsible to the latter for the wise administration of such funds as are entrusted to them, and to the former both for the energetic and careful prosecution of the scientific work and also for the due recognition and encouragement of all those workers, amateur as well as professional, whose contributions to knowledge come within the scope of their investigation. This sense of responsibility is only increased and justified by this trust which has been created for the benefit of the Marine Biological work; and the British Association Local Committee and the Subscribers to the fund may rest assured that the L.M.B.C. Officials will use their utmost endeavour to so direct the investigations that they may be a credit to Liverpool and "permanently conducive to the great aim of the British Association, the Advancement of Science."

It is the view of the Trustees, and also the desire of the L.M.B.C., that the annual interest should not be merely added to the income of the Committee, but should so far as possible be expended either upon the publication of results or upon some definite line of investigation, such as the hire of steamers for dredging explorations, or series of experiments in the Biological Station, so that the name of the fund may from time to time be publicly associated with some tangible result in such a way as to keep alive in Liverpool the memory of the British Association meeting of 1896.

It ought to be borne in mind by our own subscribers, by those of the Liverpool public who have in the past so generously helped the L.M.B.C. work, that if this British

Association Fund is to be a real advantage and bear fruit, it is absolutely necessary that our ordinary income derived from subscriptions should be in no way diminished. We confidently appeal to all those interested in any way in the Natural History of our neighbourhood to co-operate with us. Those who work with the microscope, who are collectors, who have any aptitude for practical work, will be gladly welcomed at the Biological Station or on the expeditions; while those who feel that they can only appreciate the work of others, but are interested in the extension of our knowledge of nature, can most effectively help and encourage us by adding to the slender annual income of the Committee, which is barely sufficient to meet the necessary expenses of the work at Port Erin and in Liverpool Bay.

LIST OF L.M.B.C. WORKERS.

We think it useful to give here a list of those Naturalists who are definitely working at special groups of organisms in the L.M.B.C. district, and who, as a rule, undertake the identification of the animals reported upon, and contribute information about their groups to the L.M.B.C. Reports.

BACTERIA.—Professor R. Boyce.

DIATOMACEÆ.—Dr. H. Stolterfoth.

ALGÆ.—Professor Harvey Gibson and Professor Weiss.

FORAMINIFERA.—Dr. G. W. Chaster.

DINOFLAGELLATA.—Mr. R. L. Ascroft.

INFUSORIA, &c.—Vacant.

PORIFERA.—Dr. R. Hanitsch.

HYDROID ZOOPHYTES.—Miss L. R. Thornely.

MEDUSÆ.—Mr. E. T. Browne, B.A., F.Z.S.

ACTINIARIA.—Mr. J. A. Clubb, B.Sc.

ECHINODERMATA.—Mr. H. C. Chadwick.

TURBELLARIA.—Mr. F. W. Gamble, M.Sc.

TREMATODA.—Vacant.

NEMERTIDA.—Mr. W. I. Beaumont, B.A.

ROTIFERA.—Vacant.

NEMATODA.—Vacant.

GEPHYREA, HIRUDINEA, AND OLIGOCHÆTA.—Vacant.

POLYCHÆTA.—Mr. J. Hornell and Mr. Arnold T. Watson.

POLYZOA.—Miss L. R. Thornely.

CIRRIPEDIA.—Vacant.

COPEPODA.—Mr. Isaac C. Thompson, F.L.S.

OSTRACODA.—Mr. Andrew Scott.

HIGHER CRUSTACEA.—Mr. A. O. Walker, F.L.S.

PYCNOGONIDA.—Dr. C. H. Hurst.

MOLLUSCA (TESTACEOUS).—Mr. Alfred Leicester.

NUDIBRANCHIATA.—Professor Herdman, F.R.S., and Mr. J. A. Clubb, B.Sc.

CEPHALOPODA.—Mr. W. E. Hoyle, M.A.

TUNICATA.—Prof. Herdman, F.R.S., and Miss J. H. Willmer.

FISHES.—Prof. Herdman, Mr. R. A. Dawson, and Mr. A. Scott.

SEA-BIRDS.—Dr. H. O. Forbes.

SUBMARINE GEOLOGY.—Mr. J. Lomas, Mr. G. W. Lamplugh, and Mr. Clement Reid.

PHYSICS AND CHEMISTRY OF THE SEA.—Vacant.

One of our greatest needs is a young Chemist or Physicist who would join our expeditions with the object of reporting upon the condition of the sea water at the various localities, depths and seasons.

THE LIBRARY.

The Committee consider it advisable to publish here a list of the books forming their nucleus of a working library

at Port Erin, first, for the purpose of letting workers and students know what books they will find in the laboratory, and secondly in the hope that the short list will suggest to members of the Committee, other naturalists, subscribers, and friends, some deficiencies in our library which might be made good by contributions from their own shelves. It may be convenient to state that what the Committee aim at is merely a small working library of Marine Biology, and that the most important books for their purposes—after a few standard text books and works of reference—are monographs or important papers on British Marine animals and plants.* In addition to the books in the following list, there is also in the book-case a considerable number of pamphlets kindly sent by authors, and dealing mostly with the Marine Biology of the neighbourhood. We are always glad to have such author's reprints.

ALDER and HANCOCK.—Monograph of the British Nudibranchiate Mollusca.—in seven parts. Ray Society, 1845-55.

BAIRD.—British Entomostraca. Ray Society, 1850.

BALFOUR.—Comparative Embryology. 2 vols., 1880.

BELL.—British Stalk-Eyed Crustacea, 1853.

BRADY and NORMAN.—Monograph of British Ostracoda Part I. Trans. R. Dublin Soc., 1889.

BRADY.—Monograph of the Free and semiparasitic Copepoda of the British Islands. 3 vols., Ray Soc., 1878.

* A few books and papers which have from time to time been kindly sent to the L.M.B.C., but which have no particular bearing upon British Marine Biology, have been deposited temporarily in the library of the Biological Society in Liverpool, where they will be more used and more appreciated than at Port Erin.

CAMBRIDGE NATURAL HISTORY, vol. II., 1896.

CARUS.—*Prodromus Faunæ Mediterraneæ*. 4 vols., 1885-93.

CUNNINGHAM.—*Marketable Marine Fishes*, 1896.

DAY.—*Fishes of Great Britain and Ireland*. 2 vols., 1880.

FRAIPONT.—*Recherches sur les Acinédiens, &c.*

FORBES.—*Monograph of the British Naked-Eyed Medusæ*. Ray Soc., 1848.

GOSSE.—*Manual of Marine Zoology for the British Isles*. 2 vols., 1855.

GOSSE.—*Handbook to Marine Aquarium*, 1856.

GOSSE.—*British Sea-Anemones and Corals*, 1860.

HAUCK.—*Meeres-Algen*.

HARVEY.—*Manual of British Marine Algæ*.

HELLER.—*The "Novara" Crustacea*, 1865.

HOLMES and BATTERS.—*Revised List Brit. Mar. Algæ*.

HERDMAN.—*Phylogenetic Classification of Animals*, 1885.

HERDMAN and LESLIE.—*Marine Invertebrate Fauna of the Firth of Forth*, 1881.

HERDMAN.—*Annual Reports upon the Biological Station at Puffin Island, 1888-92*. (see also *Liverpool Marine Biology Committee*).

HINCKS.—*British Hydroid Zoophytes*. 2 vols., 1868.

HINCKS.—*British Marine Polyzoa*. 2 vols., 1880.

HUGHES.—*Principles and Management of the Marine Aquarium*, 1875.

INTERNATIONAL FISHERIES EXHIBITION in London, 1883, by Huxley, Hubrecht, Holdsworth, Walpole, &c. *Addresses and papers read at the Conferences, &c.* 9 vols., 1883.

JEFFREYS.—*British Conchology*. 5 vols., 1862-69.

JOHNSTON.—*Brit. Museum Catalogue of Worms*, 1865.

- KENT.—Manual of the Infusoria. 3 vols., 1880-82.
- KORSCHOLT and HEIDER.—Text Book of Embryology of Invertebrates. 2 vols., 1895.
- LANG.—Text-book of Comparative Anatomy. 2 vols., 1891-96.
- LEE.—Microtometist's Vade-Mecum, 1893.
- LIVERPOOL MARINE BIOLOGY COMMITTEE.—Reports upon the Fauna of Liverpool Bay, &c., vols. I., II., III., IV., 1886-95.
- MALMGREN.—Annulata Polychæta, 1867.
- MARSHALL and HURST.—Practical Zoology, 1895.
- M'INTOSH.—Monograph of the British Annelids, Part I., Nemerteans, 2 vols., 1873.
- MURRAY.—Introduction to study of seaweeds.
- NICHOLSON.—Text-book of Zoology. 7th Edn., 1887.
- PENNINGTON.—British Zoophytes, 1885.
- PIZON.—Blastogénèse des Botryllides, 1892.
- POUCHET.—Changements de Coloration, &c., 1876.
- ROLLESTON.—Forms of Animal Life. 2nd Edition, by W. Hatchett Jackson, 1888.
- SARS.—Crustacea of Norway, 2 vols.
- THOMPSON.—Revised Report on the Copepoda.
- VOGT and YUNG.—Traité d'Anat. Comp. Prat. 2 vols.

PUBLICATIONS.*

The fifth volume of the "Fauna and Flora" will not be ready for a couple of years; but a revision of all the groups already reported upon has been carried out during the summer and as the result a complete list, brought up to date, was laid before Section D of the British Association and is published in the report of that meeting. Copies of this list have been reprinted, and will be issued in our

* A list of the L.M.B.C. publications will be found on p. 56 of this Report.

next volume. As references to the literature are given after the name of each species, the list forms a useful index to all the L.M.B.C. publications up to date; and in addition contains a record of all the FISHES we have obtained in the district—a group not yet reported on. The list in question appeared before the British Association as the fourth and final report of that Committee of the Association which has for some years been co-operating in the L.M.B.C. work. That report contains the following “Concluding Remarks :—

“Although this is put forward as a final report of the present Committee, they do not desire thereby to indicate that the work of exploring the zoology, botany, and geology of the Irish Sea is finished. Probably such an investigation can never be finished; but the Committee feel that the occasion of the British Association meeting in Liverpool is one that they ought to take advantage of to present a report which is final, in the sense that it completes the present series of reports, and brings together and sums up the results of all previous marine biological work in the district.

“For the future, they feel that the work will be carried on actively by the Liverpool Marine Biology Committee, the body of investigators by whom most of the work has been done in the past. The Port Erin Biological Station is equipped for such work, and the British Association can best render effective help by supporting the general investigations carried on at that station, or by giving grants for special researches.”

APPENDIX A.

 THE LIVERPOOL MARINE BIOLOGY
COMMITTEE (1896).

- R. D. DARBISHIRE, Esq., B.A., F.G.S., Manchester.
 PROF. R. J. HARVEY GIBSON, M.A., F.L.S., Liverpool.
 PROF. W. A. HERDMAN, D.Sc., F.R.S., F.L.S., Liverpool,
 Chairman of the L.M.B.C., and Hon. Director of
 the Biological Station.
 ALFRED LEICESTER, Esq., formerly of Southport and
 Liverpool.
 SIR JAMES POOLE, J.P., Liverpool.
 DR. ISAAC ROBERTS, F.R.S., formerly of Liverpool.
 I. C. THOMPSON, Esq., F.L.S., Liverpool, Hon. Treasurer.
 JOHN VICARS, Esq., formerly of Bootle.
 A. O. WALKER, Esq., F.L.S., J.P., Colwyn Bay.
 DR. SPENCER WALPOLE, formerly Governor of the Isle of
 Man.
-

CONSTITUTION OF THE L.M.B.C.

(Established March 1885.)

I.—The OBJECT of the L.M.B.C. is to investigate the Marine Fauna and Flora (and any related subjects such as submarine geology and the physical condition of the water) of Liverpool Bay and the neighbouring parts of the Irish Sea; and if practicable to establish and maintain a Biological Station on some convenient part of the coast,

II.—The COMMITTEE shall consist of not more than 12 and not less than 10 members, of whom 3 shall form a quorum; and a meeting shall be called at least once a year for the purpose of arranging the Annual Report, passing the Treasurer's accounts, and transacting any other necessary business.

III.—During the year the AFFAIRS of the Committee shall be conducted by an HON. DIRECTOR, who shall be Chairman of the Committee, and an HON. TREASURER, both of whom shall be appointed at the Annual Meeting and shall be eligible for re-election.

IV.—Any VACANCIES on the Committee, caused by death or resignation, shall be filled up by the election, at the Annual Meeting, of those who, by their work on the Marine Biology of the district, or by their sympathy with science, seem best fitted to help in advancing the work of the Committee.

V.—The EXPENSES of the investigations, of the publication of results, and of the maintenance of the Biological Station shall be defrayed by the Committee, who for this purpose shall ask for subscriptions or donations from the public, and for grants from scientific funds.

VI.—The BIOLOGICAL STATION shall be used primarily for the Exploring work of the Committee, and the SPECIMENS collected shall, so far as is necessary, be placed in the first instance at the disposal of the members of the Committee and other specialists who are reporting upon groups of organisms; but, in order to add to the funds, some of the workplaces in the Biological Station may be rented by the week or year to students and others, and duplicate specimens which, in the opinion of the Committee, can be spared may be sold to museums and laboratories.

LIVERPOOL MARINE BIOLOGICAL STATION
at PORT ERIN.

REGULATIONS.

I.—This Biological Station is under the control of the Liverpool Marine Biology Committee, the executive of which consists of the Hon. Director (Prof. Herdman, F.R.S.) and the Hon. Treasurer (Mr. I. C. Thompson, F.L.S.).

II.—In the absence of the Director, and of all other members of the Committee, the Station is under the temporary control of the Resident Curator or Laboratory Assistant, who will keep the keys, and will decide, in the event of any difficulty, which places are to be occupied by workers, and how the tanks, collecting apparatus, &c., are to be employed.

III.—The Resident Assistant will be ready at all reasonable hours and within reasonable limits to give assistance to workers at the Station, and to do his best to supply them with material for their investigations.

IV.—Visitors will be admitted, on payment of a small specified charge, to see the Aquarium and the Station, so long as it is found not to interfere with the scientific work.

V.—Those who are entitled to work in the Station, when there is room, and after formal application to the Director, are :—(1) Annual subscribers of one guinea or upwards to the funds (each guinea subscribed entitling to the use of a work place for four weeks), and (2) others who are not annual subscribers, but who pay the Treasurer 10s. per week for the accommodation and privileges. Institutions, such as Colleges and Museums, may become subscribers in order that a work place may be at the disposal of their staff for a certain period annually ; a

subscription of two guineas will secure a work place for six weeks in the year, a subscription of five guineas for four months, and a subscription of £10 for the whole year.

VI.—Each worker* is entitled to a work place opposite a window in the Laboratory, and may make use of the microscopes, reagents, and other apparatus, and of the boats, dredges, tow-nets, &c., so far as is compatible with the claims of other workers and with the routine work of the Station.

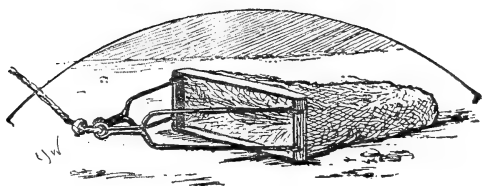
VII.—Each worker will be allowed to use one pint of methylated spirit per week, free. Any further amount required must be paid for. All dishes, jars, bottles, tubes, and other glass may be used freely, but must not be taken away from the laboratory. If any workers desire to make, preserve, and take away collections of marine animals and plants, they must make special arrangements with the Director or Treasurer in regard to bottles and preservatives. Although workers in the Station are free to make their own collections at Port Erin, it must be clearly understood that (as in other Biological Stations) no specimens must be taken for such purposes from the laboratory stock, nor from the Aquarium tanks, nor from the steam-boat dredging expeditions, as these specimens are the property of the Committee. The specimens in the Laboratory stock are preserved for sale, the animals in the tanks are for the instruction of visitors to the Aquarium, and as all the expenses of steam-boat dredging expeditions are defrayed by the Committee the specimens obtained on these occasions must be retained by the Committee (*a*) for the use of the specialists working at the Fauna of Liverpool Bay, (*b*) to replenish the tanks,

* Workers at the Station can always find comfortable and convenient quarters at the closely adjacent Bellevue Hotel; but lodgings can readily be had by those who prefer them.

and (c) to add to the stock of duplicate animals for sale from the Laboratory.

VIII.—Each worker at the Station is expected to lay a paper on some of his results—or at least a short report upon his work—before the Biological Society of Liverpool during the current or the following session.

IX.—All subscriptions, payments, and other communications relating to finance, should be sent to the Hon. Treasurer, Mr. I. C. Thompson, F.L.S., 53, Croxteth Road, Liverpool. Applications for permission to work at the Station, or for specimens, or any communications in regard to the scientific work should be made to Professor Herdman, F.R.S., University College, Liverpool.



APPENDIX B.

SUBSCRIPTIONS and DONATIONS.

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Ayre, John W., Ripponden, Halifax ...	1	1	0	—		
Banks, Prof. W. Mitchell, 28, Rodney-st.	2	2	0	—		
Bateson, Alfred, Harrop-road Bowdon ...	1	1	0	—		
Beaumont, W. I.,-Cambridge ...	1	1	0	—		
Bickersteth, Dr., 2, Rodney-st. ...	2	2	0	—		
Brown, Prof. J. Campbell, Univ. Coll. ...	1	1	0	—		
Browne, Edward T., B.A., 141, Uxbridge- road, Shepherd's Bush, London ...	1	1	0	—		
Brunner, Sir J. T., Bart., Druids Cross ...	5	0	0	—		
Boyce, Prof., University College ...	1	1	0	—		
Caton, Dr., 86, Rodney-street ...	—			1	1	0
Clague, Dr., Castletown, Isle of Man ...	1	1	0	—		
Clague, Thomas, Bellevue Hotel, Port Erin	1	1	0	—		
Comber, Thomas, J.P., Leighton, Parkgate	1	1	0	—		
Crellin, John C., J.P., Ballachurry, An- dreas, Isle of Man ...	0	10	6	—		
Darbishire, R.D., Victoria-pk., Manchester	1	1	0			
Dawkins, Professor W. Boyd, Owens College, Manchester ...	1	1	0	—		
Dumergue, A. F., 7 Montpelier-terrace	0	10	6	—		
Dwerryhouse, A. R., 8, Livingstone-av.	1	1	0	—		
Gair, H. W., Smithdown-rd., Wavertree	2	2	0	—		
Gamble, Col. C.B., Windlehurst, St. Helens	2	0	0	—		
Gamble, F.W., Owens College, Manchester	1	1	0	—		
Gaskell, Frank, Woolton Wood ...	1	1	0	—		
Gaskell, Holbrook, J.P., Woolton Wood	1	1	0	—		
Gell, James S., High Bailiff of Castletown	1	1	0	—		
Forward ...	£31	3	0	1	1	0

Forward ...	31	3	0	1	1	0
Gibson, Prof. R. J. Harvey, 5, Adelaide- terrace, Waterloo	1	1	0	—		
Glynn, Dr., 62, Rodney-street	2	2	0	—		
Greening, Linnæus, 5, Wilson Patten-st., Warrington	1	1	0	—		
Gotch, Prof., Museum, Oxford	1	1	0	—		
Halls, W. J., 35, Lord-street	1	1	0	—		
Hanitsch, Dr., Museum, Singapore	1	1	0	—		
Henderson, W. G., Liverpool Union Bank	1	1	0	—		
Herdman, Prof., University College	2	2	0	—		
Holder, Thos. (the late), 1, Clarendon- buildings	1	1	0	—		
Holland, Walter, Mossley Hill-road	2	2	0	—		
Holt, Alfred, Crofton, Aigburth	2	2	0	—		
Holt, George, J.P., (the late), Sudley, Mossley Hill	1	0	0	—		
Hoyle, W. E., Museum, Owens College, Manchester	1	1	0	—		
Isle of Man Natural History and Anti- quarian Society	1	1	0	—		
Jones, C.W., J.P., Field House, Wavertree	1	0	0	—		
Jones, C. E. E., Prenton-road, B'head	1	1	0	—		
Kermode, P. M. C., Hill-side, Ramsey...	1	1	0	—		
Lea, Rev. T. Simcox, 3, Wellington-fields	1	1	0	—		
Leicester, Alfred, Buckhurst Farm, Eden- bridge, Kent	1	1	0	—		
Macfie, Robert, Airds	1	0	0	—		
Meade-King, H. W., J.P., Sandfield Park	1	1	0	—		
Meade-King, R. R., 4, Oldhall-street	0	10	0	—		
Melly, W. R., 90, Chatham-street	1	1	0	—		
Monks, F. W., Brooklands, Warrington	1	1	0	—		
Muspratt, E. K., Seaforth Hall	5	0	0	—		
Narramore, W., 5, Geneva-rd., Elm Park	1	1	0	—		
Forward ...	65	18	0	1	1	0

Forward ...	65	18	0	1	1	0
Newton, John, M.R.C.S., 44, Rodney-st.	0	10	6	—		
Poole, Sir James, Tower Buildings ...	2	2	0	—		
Rathbone, S.G., Croxteth-drive, Sefton-pk.	2	2	0	—		
Rathbone, Mrs. Theo., Backwood, Neston	1	1	0	—		
Rathbone, Miss May, Backwood, Neston	1	1	0	—		
Rathbone, W., Greenbank, Allerton ...	2	2	0	—		
Roberts, Isaac, F.R.S., Crowborough ...	1	1	0	—		
Simpson, J. Hope, Annandale, Aigburth-dr	2	2	0	—		
Smith, A. T., junr., 24, King-street ...	1	1	0	—		
Talbot, Rev. T. U., 4, Osborne-terrace, Douglas, Isle of Man ...	1	1	0	—		
Thompson, Isaac C., 53, Croxteth-road	2	2	0	—		
Thornely, James, Baycliff, Woolton ...	1	1	0	—		
Thornely, The Misses, Baycliff, Woolton	1	1	0	—		
Toll, J. M., Kirby Park, Kirby ...	1	1	0	—		
Walker, A. O., Nant-y-glyn, Colwyn Bay	3	3	0	—		
Walker, Horace, South Lodge, Princes-pk.	1	1	0	—		
Walters, Rev. Frank, B.A., King William College, Isle of Man...	1	1	0	—		
Watson, A. T., Tapton-crescent, Sheffield	1	1	0	—		
Weiss, Prof. F. E., Owen's College, Man'tr.	1	1	0	—		
Westminster, Duke of, Eaton Hall ...	5	0	0	—		
Wiglesworth, Dr., Rainhill ...	1	1	0	—		
			<hr/>	<hr/>		
			£98 14 6	1 1 0		
			<hr/>	<hr/>		

SUBSCRIPTIONS FOR THE HIRE OF "WORK-TABLES," OCCUPIED
BY COLLEGES, &c.

Liverpool Museum Committee ...	£2	2	0
Owens College, Manchester ...	10	0	0
University College, Liverpool ...	10	0	0
<hr/>			
£22 2 0			
<hr/>			

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.

Dr.

IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER.

Ct.

1896.		1896.	
	£ s. d.		£ s. d.
To Balance due Treasurer, Dec. 31st, 1895.....	5 13 5	By Subscriptions and Donations actually received.....	107 1 6
" Printing Reports, vol. iv. "Fauna," Plates, &c. ...	46 13 10	" Amount received from Colleges, &c., for hire of	
" Printing and Stationery	1 9 3	" "Work Tables"	22 2 0
" Expenses of Dredging Expeditions.....	17 4 3	" Dividend, British Workman's Public House Co.,	
" Boat Hire.....	8 16 2	Ltd., Shares	5 18 9
" Reade's Portable Shellbend Boat.....	15 0 0	" Sale of Reports and Volumes of Fauna	23 5 7
" Books and Apparatus at Port Erin Biological Station	20 6 7	" Bank Interest.....	0 4 4
" Postage, Carriage of Specimens, &c.	4 9 1	" Admissions to Aquarium	3 17 0
" Salaries, Curator and Laboratory Boy	28 12 3	" Balance due Treasurer, Dec. 31st, 1896	4 10 9
" Rent of Port Erin Biological Station	15 0 0		
" Repairs, Bookcase, &c.	3 5 8		
" Sundries	0 9 5		
	<u>£166 19 11</u>		<u>£166 19 11</u>

Endowment Investment Fund :—
British Workmans' Public House Co's. shares£173 1 0

ISAAC C. THOMPSON,

HON. TREASURER.

LIVERPOOL, December 31st, 1896.

Audited and found correct,

A. T. SMITH, JUNR.

L.M.B.C. NOTICES.

The public are admitted by ticket to inspect the Aquarium at suitable hours daily, when the Assistant will be, as far as possible, in attendance to give information. Tickets of admission, price threepence each, to be obtained at the Biological Station or at the Bellevue Hotel. The various tanks are intended to be illustrative of the marine life of the Isle of Man. It is intended also that short lectures on the subject should be given from time to time by Prof. Herdman, or by others of the Committee.

Applications to be allowed to work at the Biological Station, or for specimens (living or preserved) for Museums, Laboratory work, and Aquaria, should be addressed to Professor Herdman, F.R.S., University College, Liverpool.

Subscriptions and donations should be sent to Mr. I. C. Thompson, F.L.S., 53, Croxteth Road, Liverpool.

The surplus copies of the 5 Annual Reports upon the Marine Biological Station formerly on Puffin Island (1888 to 1892, the complete set) have been collated and bound up to form an 8vo. volume of about 180 pages, illustrated with cuts and plates, and containing the original lithographed covers. There are 20 copies of this vol., which are now offered by the Committee at 3/- each nett.

Copies of the Annual Reports for 1893, 1894, and 1895 can also be had, price one shilling each (all post free).

The L.M.B. Committee are publishing their Reports upon the Fauna and Flora of Liverpool Bay in a series of 8vo. volumes at intervals of about three years. Of these there have appeared :—

Vol. I. (372 pp., 12 plates), 1886, price 8/6.

Vol. II. (240 pp., 12 plates), 1889, price 7/6.

Vol. III. (400 pp., 24 plates), 1892, price 10/6.

Vol. IV. (475 pp., 53 plates). 1895, price 10/6.

Copies of any of the above publications may be ordered from the Liverpool Marine Biology Committee, University College, Liverpool, or from the Hon. Treas., 4, Lord Street, Liverpool.

ISAAC C. THOMPSON,

Hon. Treas.

REPORT on the Investigations carried on in 1896
in connection with the LANCASHIRE SEA-FISHERIES
LABORATORY at University College, Liverpool.

By Professor W. A. HERDMAN, D.Sc., F.R.S.; and
Mr. ANDREW SCOTT, Fisheries Assistant.

With Plates I—IV.

CONTENTS.

INTRODUCTION.

PART I. By Andrew Scott.	PART II. By W. A. Herdman.
Food in Fishes' Stomachs.	Sea-Fish Hatching Experiments.
Mussels.	The Oyster Investigation.
Bouchot Experiment.	The Marine Laboratory at Piel.
Mussel beds.	Explanation of Plates.
Cockles and Cockle beds.	APPENDIX—Catalogue of the Sea-
Lobsters.	Fisheries Museum.

INTRODUCTION.

IN reporting upon the progress made during the past year, in addition to a continuation of the usual work on the food and reproductive condition of the fish and shell-fish sent into the laboratory, and a further examination of the cockle and mussel beds of Morecambe Bay, we have to record the commencement of "bouchot" mussel experiments, a good deal of additional work on oysters and disease, and finally a new departure in the artificial fertilisation and hatching of young sea-fish.

Mr. Scott has made several visits during the year, in the steamer, to the off-shore fishing grounds, for the purpose of getting further information regarding the feeding habits of the edible fish. Visits have also been made to the various spawning grounds in order to collect

fish eggs for the experimental hatching at Port Erin. The shellfish beds in the neighbourhood of Piel Island in Morecambe Bay have also been visited on several occasions when samples were taken, and this will be done more systematically in the future when the marine laboratory at Piel is ready for occupation. In the latter part of the year a good deal of Mr. Scott's time has been occupied in preparing illustrations, both in the form of photographs* to be used as lantern slides and also specimens of all kinds microscopic and otherwise, for the course of Free Fishery Lectures and Demonstrations to be given in connection with the Fisheries Museum at University College, Liverpool, in the early part of 1897.

The Sea-Fisheries Collection in the College Museum, to which both Mr. Scott and I have given a good deal of time and trouble, has now been gone over, added to, rearranged and labelled, and is ready for inspection. It has already had a good many visitors, and will without doubt prove of great advantage in connection with the coming Demonstrations. We have prepared a Catalogue of the Collection showing the arrangement, and giving some information in regard to the exhibits. This catalogue is appended to the present report as it will probably be of interest to the members of the Committee and to other readers.

I believe that such collections as this—especially if made the subject of occasional lectures and demonstrations—will be of considerable importance in diffusing amongst the public a knowledge and appreciation of our Sea-Fisheries and of the methods and objects of Sea-Fisheries investigation.

My object has been, in arranging the present course of

* Instantaneous photographs have been taken of the various methods of fishing in different parts of the district.

Fishery lectures, not to give all the lectures myself as I did on the previous occasion, but to ask various gentlemen who have devoted special attention to some one branch of the subject to give a lecture each on his own speciality. All those I asked at once kindly consented to co-operate, and they have all, I know, taken a great deal of personal trouble in the matter. There is every prospect that these lectures will be a success. They are advertised as follows:—

A Course of short Lectures and Demonstrations on “Fish and Fisheries” will be given in the Zoology Lecture Theatre and the Fisheries Room in the New Museum of Zoology (University College, Liverpool) on Monday evenings at 8 o’clock, commencing on January 18th, 1897. The Lectures and Demonstrations will be illustrated by the Electric Lantern, and by the specimens in the Fisheries Collection. They are open free to the Public. The Course will be as follows:—

Jan. 18th. The present position of our Fishing Industries, and what Biological investigations might do; with a demonstration, from models, of Capt. Dannevig’s Sea-Fish Hatchery at Flödevigen in Norway.

To be given by Prof. HERDMAN, F.R.S.

Jan. 25th. The need and objects of Sea-Fisheries Committees, with illustrations of the Fishing Grounds, and the different methods of Fishing in our District.

To be given by Mr. R. A. DAWSON,
Superintendent of Fisheries.

Feb. 1st. Some methods of Fishing and of Fish Culture in other European Countries.

To be given by Mr. R. L. ASCROFT,
Member of the Sea-Fisheries Committee,

Feb. 8th. Fish Parasites, and some constituents of the
 food of fishes.

 To be given by Mr. ISAAC C. THOMPSON,
 F.L.S.

Feb. 15th. Crabs and Lobsters, their habits and life-
 history.

 To be given by Mr. ANDREW SCOTT,
 Fisheries Assistant.

Feb. 22nd. The Bacteriology of Fish, and the Connec-
 tion of Fish with Disease.

 To be given by Professor BOYCE, M.B.

 If these lectures are appreciated in Liverpool it might
be worth while to repeat some of them at other Fishery
Centres throughout the district.

 W. A. HERDMAN.

JANUARY 1st, 1897.

PART I.

By Mr. ANDREW SCOTT.

FOOD IN FISHES' STOMACHS.

DURING the past twelve months, 630 stomachs of fish collected in various parts of the district have been examined, with the view of obtaining further information as to the food of our more important food fishes, and also for comparison with the results arrived at in former years.

Of the true fishes, fully two-thirds of the stomachs were empty or contained food matter that could not be identified, the remainder gave results practically identical with what has been recorded in our previous reports. Therefore it is not considered necessary to give again a detailed account of the contents of the stomachs in each species of fish. All our results are recorded on forms and are available for consultation or for statistical purposes at any future time.

MUSSELS.

Besides keeping up the examination of the stomachs of this shellfish, an endeavour has been made to gain further information regarding the time when the spawning takes place in our own district. So far, the results bear out the conclusions arrived at and stated in the report for 1894, viz.:—that “the Mussel reaches maturity about the middle of May.”

THE BOUCHOT EXPERIMENT.

An experimental Mussel Bouchot has been erected on the shore behind Foulney Island in Barrow Channel.

This Bouchot, which is placed between Roosebeck outer scar and Foulney Island, is somewhat similar to those used in the Bay of Aiguillon in France. It consists of a single row of stakes, placed at intervals of about 3 feet, extending in a straight line for 52 yards, the position being at right angles to the length of the Island and roughly parallel to the shore of the mainland. The stakes are interlaced with flexible branches, and sufficient space is left at the bottom for mud, seaweed, and other things to wash through. The Bouchot was erected during the summer and was stocked with mussels on the 11th and 12th August, 1896, one-half of these being taken from the outer scar and the other half from the beds in the immediate neighbourhood. The methods employed in fixing them to the Bouchot were two:—good sized bunches of young mussels were selected, tied up in pieces of old net and then stuffed into the spaces amongst the interlacing twigs; and good sized and fairly compact bunches were put amongst the twigs, without net or other supporting material.

On the 7th October the Bouchot was again visited and found to be intact, but many of the mussels had been washed off, both those protected by the net and those unprotected. A considerable number, however, of the mussels had become firmly attached to the twigs. On October 8th a strong gale got up, which raised the tide to such an extent, that Foulney Island was completely submerged, as well as large tracts of low-lying land along the shore of the mainland, causing considerable destruction to property. When the gale moderated the Bouchot was visited and was found to have stood well, no damage being done to the structure itself, although a considerable number of the mussels had been swept off, leaving the Bouchot comparatively bare in places. As the weather

still continued stormy, it was considered inadvisable to attempt to re-stock the Bouchot at that time, but the fishery officers at Piel who had assisted at the first stocking were instructed to add a fresh supply of young mussels at the first convenient opportunity.

The experiment so far shows that it is possible to have mussel Bouchots like those in France on the less exposed parts of this coast, and that the mussels when put on will readily attach themselves to the twigs. It now remains to be seen, to what extent the spat produced in the neighbourhood during the coming season will settle down and remain upon the structure. A further point that will then arise is the financial one—a comparison between the results obtained and the cost.

THE MUSSEL BEDS.

The Roosebeck outer scar was visited on August 11th, for the purpose of collecting mussels to put on the Bouchot, and the opportunity was taken to note the condition of the bed.

The mussels, which were reported upon last year, were found to be flourishing, and in good condition, measuring on an average one and a quarter inch in length, that being an increase of half an inch since last year. There is every appearance of a valuable yield of shellfish from this bed, at no very distant date, probably not more than two years hence, as the conditions still seem to continue favourable for a rapid growth.

Owing to the insecure foundation of this bed, large quantities of the mussels have been washed off into the deeper water outside the scar, and it is here that a Bouchot might be of considerable service, for there appears to be no reason why mussels should not grow as rapidly on a structure of this kind as on the soft mud of the bed and

they would be less liable to be washed away, when once they had securely attached themselves to the twigs.

There is a small mussel bed at Mort Point near the Piel end of Baicliff cockle bed. The mussels on this bed appear to represent two stages of growth. On the inner part of the scar, where the bottom is largely composed of stones, the mussels are from $1\frac{1}{4}$ inches to 2 inches in length but are covered with the elongated variety of *Balanus crenatus*, Brug., in some cases to such an extent as to leave little of the mussel shell visible. The outer part of the bed, that nearest to the sea, is covered with a set of young mussels ranging from $\frac{3}{4}$ of an inch to $1\frac{1}{2}$ inches, but the larger size are comparatively scarce. The mussels here, are not unlike those on the outer scar at Roosebeck. The shells are quite free from barnacles, which seems to be commonly the case with mussels which are only exposed during the ebb of spring tides. Mussels, stones, wooden posts, &c., which are exposed to the air at every ebb appear to be more frequently covered with barnacles, than is the case with similar objects only seldom exposed.

The presence or absence of barnacles upon mussels is no guide to the quality of the fish inside, but the scars left when they have been cleaned off give the shells an unsightly appearance, and so may affect their sale.

COCKLES AND COCKLE BEDS.

The work carried out during the past year in connection with the investigation into the food, spawning time, and other points connected with the life-history of the cockle, has been on similar lines to those on the mussel.

The constituents of the food supply of this shellfish are in all points similar to those that the mussel feeds upon, and consist chiefly of diatoms, spores of algæ and other vegetable remains.

The Baiclyff Cockle Bed was visited and examined during the low tides of October, but the week of stormy weather which set in at that time interfered somewhat with the work. However we were able to form a fair estimate of the size of the bed and to observe the conditions under which the cockles live.

The shore here consists for the greater part of a flat stretch of clean sand extending from Mort Point, right on towards Bardsea and on the seaward side into the water. The cockles grow and reproduce under the most favourable conditions as there appears to be no lack of food in the shape of diatoms and other vegetable matter, which could be easily seen spread in golden patches all over the sand, in the little hollows left by the retiring tide.

The cockles on the bed are very numerous; they are in good condition, but of small size. The larger sizes have now been almost entirely removed by the fishermen, and the younger ones having not yet grown to maturity, a very considerable number of them are therefore under the regulation size.

LOBSTERS.

A small experimental tank has now been laid down at Piel, for the purpose of ascertaining whether it would be possible to keep lobsters in confinement and rear them there.

This tank measures 6 feet by 5 feet by 2 feet, and is placed on the north side of the gutter that runs past the end of the embankment formed by the old pier. The tank is held down in position by iron stakes, which are fixed one at each of the four corners, but as these were found to be insufficient for the purpose a number of large stones had to be placed inside to keep the tank on the bottom. These stones were afterwards found to be of service in giving shelter to the lobsters. The tank is

covered on the top with galvanised wire netting, having a padlocked door at one side, for the purpose of giving access to examine the lobsters and for cleaning purposes. By means of a hole bored in the bottom, and fitted with a plug, the tank can be completely emptied.

The first lobster was put in on June 27th, it is a male measuring then $8\frac{1}{2}$ inches in length, and was caught by Mr. Wright on the scar near the moorings of the police boat. By October 7th other six lobsters had been caught on the scar and placed in the tank; one of these, a small male measuring $4\frac{1}{2}$ inches, subsequently escaped through the meshes of the wire netting. Of the six remaining lobsters, two are females, and four males; they have apparently become quite accustomed to their new surroundings and are very lively. Abundance of food is supplied by the fishery officers, in the form of dead and living fish; the lobsters may also be able to capture in the tank small crustacea, such as young shrimps, etc., which are fairly abundant in the neighbourhood.

Along with the lobsters, a few crabs measuring about $4\frac{1}{2}$ inches across, were also put in the tank, and these seem to be doing equally well; one of the crabs has cast its shell.

So far as the experiment has gone, it tends to show that it is possible to keep lobsters alive in captivity at Piel, and that they will remain in a healthy condition. The next point that remains to be seen is, when we get the ova, whether it is possible to hatch out the young lobsters and carry them through the early stages in their life-history. With the new laboratory at Piel in working order there should be no great difficulty in doing so.

PART II.

By Professor W. A. HERDMAN.

THE SEA-FISH HATCHING EXPERIMENTS.

IN various previous reports I have referred to the importance of instituting as soon as possible actual experiments in sea-fish hatching in order to determine what can be done in our own district in the artificial or semi-artificial propagation of sea-fishes. As the Port Erin Biological Station, belonging to the Liverpool Marine Biology Committee, offered in its Aquarium house and tanks, and in the specially pure sea-water off the south end of the Isle of Man, special facilities for such observations, it was decided to commence the experimental work at that establishment. An additional inducement to attempt hatching first at Port Erin was the presence of an important spawning ground within easy reach from which more readily than in any other part of the district we could obtain a supply of spawning fish, and ripe males.

Accordingly with the help of a small grant to fit up additional wooden tanks, we undertook, during the last hatching season (Easter 1896), a series of observations for the Lancashire Sea-Fisheries Committee. As the result of these experiments we successfully fertilised the eggs (obtained from the parent fish caught with the trawl) of the grey Gurnard (*Trigla gurnardus*), the lemon Sole (*Pleuronectes microcephalus*), and the Witch (*Pleuronectes cynoglossus*), and kept them in the tanks until they hatched out as young larvæ. We were not prepared in this first season to proceed with the rearing; but we propose, with additional tanks and an improved circulation

of water, to carry the work a stage further next season, and also to try the same experiments in similar tanks at the Piel (Roa Island) laboratory.

Last April we fitted up, in the lower floor of the Aquarium house at Port Erin, three wooden hatching tanks, each 5 feet by 3 feet by 1 foot, and so arranged, like steps, that water could flow by bamboo spouts covered with a fine silk net through the series of tanks. From the lowest wooden tank the water fell into a concrete floor tank, into which dipped an endless chain formed of an india-rubber belt bearing numerous little buckets. This chain of buckets revolved on a drum, octagonal in section, which was kept in motion by india-rubber belting passing from its axle to a pulley on a large water-wheel actuated by the fresh water tap (see Pl. I.).*

Consequently, by turning the tap the whole apparatus was set in motion, and the sea-water from the concrete floor tank was raised by the little buckets and emptied into a sloping wooden trough which guided it to the upper hatching tank. Thus the same water was used over again, a couple of gallons of fresh sea-water being added to the system every day.

During the period when the apparatus was working the temperature and the specific gravity of the water in the tanks kept fairly constant, the extremes of the range being :—

Temperature from 50° to 53° F., and

Specific gravity from 0·0265 to 0·0270.

Each of the three tanks had a partition 1 foot from its outflow end which stopped 2 inches from the top, and a second partition 6 inches nearer the end which reached

*The tanks and the water motor apparatus were made most carefully and ingeniously, from our plans, by Mr. R. Garner, superintendent of the wood-working department at University College, Liverpool.

the top but stopped short 2 inches from the bottom of the tank. In the two compartments imperfectly separated by this last partition, clean washed sand was placed so as to reach to about 4 inches from the bottom. Consequently all water escaping from the tank had to flow over the first partition and *under* the second, filtering through the bed of sand as it went. The object of this was to form a sand trap which would let the water pass through, but keep back the suspended fish eggs and embryos. By this method the same water can be used to circulate through several tanks containing different kinds of embryos.

When on a dredging expedition on April 5th in the steam-trawler "Rose-Ann" we brought up from the deep channel, 12 miles S.W. of the Calf, bottom reamy mud, depth 40 to 50 fathoms, a large number of spawning Hake, Ling, Haddock, Plaice, and Witches. In fact nearly every fish brought up from that spot was mature, and the spawn was running out in quantities on the deck. When I reported this to Mr. Dawson he arranged to bring the "John Fell" over as soon as could be managed. She arrived at Port Erin on Tuesday evening, April 21st, and on Wednesday 22nd we were out trawling all day, on the ground 12 miles S.W. of the Calf, and from there northwards towards Port Erin, with very poor results. We boarded the steam-trawlers "Lady Loch" and "Oceanic" which were working on the same ground, but got practically no spawning fish in quantity. The only spawn we were able to collect and fertilise was from some Witches (*Pleuronectes cynoglossus*). This was taken to the laboratory and, as I considered it scarcely worth putting in one of the hatching tanks, it was placed in an earthenware vessel, where most of it afterwards hatched out. The next day we again had practically no success; and so, on the following day, Friday, 24th, we tried further north,

about 8 miles off Dalby, reamy bottom, depths 20 to 40 fathoms, where I had in former seasons found spawning Soles, Turbot and Brill. Here we were very successful, and obtained spawning Plaice, Witch, Lemon Sole, and grey Gurnard. These batches of eggs were fertilised in pails on board ship and were conveyed to the laboratory. The plaice spawn met with an accident, but the other three samples were safely transferred one to each of the three tanks prepared for their reception, where they were kept under observation during the following two weeks.

Although the early history of such fish has been followed elsewhere, we think it will be of interest to the Committee to see figures of the first food fishes which have been artificially fertilised and hatched in our district. Plates II. to IV., drawn by Mr. Andrew Scott, show diagrammatically the various embryonic stages of the three kinds of fish during their development.

The first batch of Witch embryos fertilised on the 22nd began to hatch out on the 29th, the seventh day, the majority of them died on the following day.

The second batch of Witches, fertilised on April 24th, and the Lemon Soles of the same date began to hatch on Saturday, May 2nd, and by Sunday afternoon nearly all of them had left their egg membranes. A few of them died on Monday, and more on the following day.

The Gurnards were later, and many of them died or became abnormal before hatching.

When the "John Fell" left Port Erin on the evening of the 24th, Mr. Scott went with her to try to obtain some more spawn on other grounds. The neighbourhood of the Bahama and King William banks were tried without success, and then on the Monday morning, by the kind permission of Mr. Knox of Douglas, the owner of the "Rose-Ann," Mr. Scott was permitted to join that trawler

during her cruise. He saw 8 hauls made and examined the fish, but no fertilised eggs could be secured. Most of the fish were "spent," and of those few species of which ripe females were obtained no mature males were forthcoming. Consequently no further experiments could be tried at that time at Port Erin. This season the endeavour should be made to obtain spawn a good deal earlier—not later than the beginning of March—in order to continue the observations at Port Erin and also to start a similar series of experiments at the Piel laboratory in the Barrow Channel.

THE OYSTER INVESTIGATION.

Since last year's report the work on Oysters under various conditions, and their possible connection with disease in man, has been carried on actively in the University College laboratories. As it was obvious that a very important part of the investigation consisted in the determination of the action and behaviour of the typhoid organism (*Bacillus typhosus*) in sea-water and in the body of the Oyster, a great part of the work has been carried out by Professor Boyce in the Bacteriological laboratory. We have also, in the Zoological department, had under observation a number of oysters which after infection with the typhoid organism were placed in a stream of constantly running sea-water, in order to ascertain whether pathogenic organisms can be satisfactorily removed by washing—or rather by allowing the oyster the opportunity of passing fresh water through its body. As a result of these experiments, a report was drawn up which was read by Professor Boyce, on September 23rd, before the Physiological Section at the Liverpool Meeting of the British Association. From that report I extract the following tables and statements;—

The present report deals almost exclusively with the Bacteriology of the oyster and the behaviour of the *Bacillus typhosus* in sea-water and in the body of the oyster. The subject of the green colouration in oysters is also discussed but will be treated more fully in a subsequent report. The questions investigated are the following:—

- I. The identification and differentiation of *Bacillus typhosus* and *B. coli communis*.
- II. The action of sea-water upon the growth of *B. typhosus*.
- III. The Bacteria present in the alimentary canal of the oyster.
- IV. The infection of the oyster with *B. typhosus*, and its removal by washing.
- V. The green colouration and green disease in oysters.

I.—The Identification and Differentiation of *Bacillus typhosus* and *B. coli communis*.

We have systematically tested the majority of the chief differential reactions upon samples of *Bacillus typhosus* and *B. coli* obtained from numerous sources, and have in all cases found unmistakable differences between the two bacilli.

Table showing Differences of Reaction.

Source	Fermentation. Glucose Gelatine	Indol Reaction	Coagula- tion	Potassium Iodide Potato Gelatine
A. <i>B. typhosus</i> .				
1. Institut Pasteur	none	none	none	very small growth
2. From spleen of typhoid patient	"	"	"	"
3. Prof. Delépine	"	"	"	"
4. Prof. Wright (Netley).	"	slight trace	clot slowly formed	"
5. } Dr. S. Woodhead	"	none	none	"
6. }	"	"	"	"
7. }	"	"	"	"
8. } Dr. Kanthack	"	"	"	"
9. }	"	"	"	"
10. Institute of pre- ventive Medicine	"	"	"	"

B. <i>B. coli</i> .				
1. Institut Pasteur	well marked	marked pink	marked	growth abundant
2. Prof. Delépine	"	slight pink	"	"
3. Prof. Wright	"	pink	"	"
4.)	"	slight pink	"	"
5.)	"	marked pink	"	"
6.)	"	pink	"	"
7. } Dr. S. Woodhead	"	"	"	"
8. }	"	"	"	"
9. }	"	"	"	"
10. }	"	"	"	"
11. }	"	"	"	"
12. } Dr. Kanthack	"	slight pink	"	"
13. }	"	absent	"	"
14. Institute of Preventive Medicine	"	"	"	"

Summary of Constancy or Variability of Reactions.

A. For *B. typhosus* :—

1. *Fermentation test*. Constant (Burri and Stutzer have shown gas formation).
2. *Indol reaction*. Slight indication in one case.
3. *Milk Coagulation*. Slight clot in one case.
4. *Potassic iodide potato gelatine*. Characteristic invariably, very little use as a separating medium.
5. *Potatoes*. Constant with usual precautions.
6. *Reaction in gelatine*. Marked differences of rate of diffusion.

B. For *B. coli* :—

1. *Fermentation*. Rate of gas formation variable, otherwise constant.
2. *Indol reaction*. Reaction not constant.
3. *Milk coagulation*. Rate variable. Constant with us, with others not constant.
4. *Potassic iodide potato gelatine*. Abundant growth.
5. *Behaviour in gelatine*. Diffusion very variable, in many cases less rapid than *B. typhosus*.
6. *Motility*. Very variable.

II.—The Action of Sea-water upon the Growth of the *B. typhosus*.

EXPERIMENT I.				EXPERIMENT IV.			
			No. of Bacilli				No. of Bacilli
At time of mixing	-	-	29,250	At time of mixing	-	-	130
After 21 hours	-	-	20,475	After 6 hours	-	-	41
" 45 "	-	-	9,945	" 23 "	-	-	31
" 71 "	-	-	9,360	" 48 "	-	-	38
" 95 "	-	-	5,850	" 72 "	-	-	negative
" 271 "	-	-	260	" 247 "	-	-	1
" 340 "	-	-	11	" 316 "	-	-	0
EXPERIMENT II.				EXPERIMENT V.			
At time of mixing	-	-	1,300	At time of mixing	-	-	31,200
After 21 hours	-	-	1,105	After 172 hours	-	-	9,360
" 45 "	-	-	780	" 244 "	-	-	325
" 71 "	-	-	650				
" 95 "	-	-	325				
" 271 "	-	-	2				
" 340 "	-	-	0				
EXPERIMENT III.				EXPERIMENT VI.			
At time of mixing	-	-	22,750	At time of mixing	-	-	325
After 5 hours	-	-	17,550	After 172 hours	-	-	2
" 23 "	-	-	11,700				
" 48 "	-	-	3,250				
" 72 "	-	-	3,260				
" 247 "	-	-	455				
" 316 "	-	-	325				
				EXPERIMENT VII.			
				At time of mixing	-	-	325
				After 504 hours (water kept	-	-	
				at 8° C. to 10° C.)	-	-	79
				EXPERIMENT VIII.			
				At time of mixing	-	-	325
				After 504 hours	-	-	0

These results are fairly uniform. When a large number of Bacilli are added to the water their presence may be demonstrated longer than in cases where small quantities are used. Fourteen days would appear to be the average duration in sea-water incubated at 35°C., whilst when kept in the cold their presence was demonstrated on the twenty-first day.* There appears to be no initial or subsequent multiplication of the Bacilli. Between 40 and 70 hours after infection there is less decrease than at other periods; but there is no evidence of increase in numbers of the Bacilli when grown in sea-water either when incubated or at ordinary temperatures. We do not think, however,

* Dr. Cartwright Wood, however, finds that the typhoid Bacilli may possibly persist for two months.

that these experiments can be taken without reserve as an indication of what might take place in nature.

III.—The Bacteria present in the Alimentary Canal of the Oyster.

This research has proved of very considerable utility in guarding us against errors in our subsequent infection experiments, and is of further interest in demonstrating the large number of cases in which the colon bacillus was normally present.

Methods.—In analysing the contents of the stomach we have, in all cases, cauterised the mantle over the region of the stomach and have inserted a sterilised fine glass pipette and withdrawn a quantity of fluid varying from $\frac{1}{20}$ to $\frac{1}{40}$ of a cubic centimetre. The contents of the tube have then been mixed with liquefied agar, ordinary gelatine or sea-water gelatine and Petri dishes made. The agar dishes have been incubated at 37°C., the gelatine at 21°C. to 24°C. As the figures will subsequently demonstrate there is an enormous difference between the number of organisms appearing upon the agar incubated at the high temperature and the simple or sea-water gelatine incubated at the low temperature. This heat method of separation proved quite equal to, if not better than, the carbolic acid or potassic iodide methods.

Experiments.—In the first six cases examined, precautions were taken to ensure that the oysters were especially fresh, in the other cases they were obtained haphazard from the various shops (see table).

The number of organisms taken from the stomach of the oyster which could survive a temperature of 37°C., was comparatively small. In a very large proportion of cases ($\frac{1}{3}$ to $\frac{1}{2}$) the organism present was *B. coli* in overwhelming numbers, and next in frequency were species

Oysters	No. of Colonies		Bacillus isolated giving following Reactions :					
	Agar	Salt-water Gelatine	Fermen- tation	Indol	Coagula- tion	KI Gelatine	Motility	—
<div> <div> <div>A</div> <div>B</div> <div>C</div> <div>D</div> <div>E</div> <div>F</div> </div> </div>	<div> <div>0</div> <div>5</div> <div>0</div> <div>0</div> <div>1</div> <div>6</div> </div>	not made						} <i>B. coli</i> not looked for
Shop 2 {	108							
	1,040		active	marked	marked	marked	—	
„ 4 {	390							
	455							
	2							
	2		active	marked	marked	marked	very motile	decolorised
	102							
„ 5 {	350							
	12							
	1,170							
	21							
	195							
„ 6 {	5							
	20							
„ 7 {	3							
	2							
„ 8 {	3							
	70		active	none	marked	marked	motile	decolorised
	9		active	none	marked	marked	—	decolorised
„ 9 {	5							
	65							
	260							
„ 10 {	195							
	520							
„ 11 {	65		active	marked	marked	marked	motile	decolorised
	70							
„ 12 {	650							
	260		active	none	marked	marked	motile	decolorised
„ 13 {	150		active	marked	marked	marked	motile	decolorised
	195							
„ 14 {	6		none	none	marked	marked	motile	decolorised
	2							
„ 15 {	100		active	marked	marked	marked	motile	decolorised
	5							
„ 16 {	20		active	marked	marked	marked	motile	decolorised
	70							
„ 18 {	25	3,025	active	marked	marked	marked	motile	decolorised
„ 19 {	1	2,330						
„ 20 {	265	13,000						
„ 21 {	100	1,755	active	marked	marked	marked	motile	decolorised
„ 22 {	35	2,330	active	marked	marked	marked	motile	decolorised
„ 23 {	15	3,025	active	marked	marked	marked	motile	decolorised
„ 24 {	40	6,500						
„ 25 {	5	13,000						
„ 26 {	2	8,775						
„ 29 {	325	17,550	active	marked	marked	marked	motile	decolorised
„ 30 {	50	20,475						
„ 31 {	65	2,925	active	marked	marked	marked	motile	decolorised

of *Proteus*. It will be seen that in one instance, at least, the organism approached in its reactions the typhoid type. We believe that on account of the presence of this coli group, the identification of the *B. typhosus* would be difficult in nature. We cannot at present state whether the coli group found in these experiments indicates sewage contamination, or whether, as is quite likely, we are dealing with a group common in the intestine of the oyster and in salt-water. The matter is being investigated by us. But, as bearing upon the next question, we have found that the perfectly fresh oyster contains far fewer bacteria and that the percentage of *B. coli* is much less.

IV.—The Infection of the Oyster with the *B. typhosus*, and its removal by washing.

The following table shows that the typhoid bacillus does not increase in the body or in the tissues of the oyster. The figures would rather indicate, comparing the large number of bacilli present in the water with those found in the alimentary tract, that the bacilli perish in the intestine.

*Table showing Number of Organisms present in
Stomach after infecting Water.*

Oyster	Inoculated	Examined	No. of Colonies	Organisms present in Oyster	Number present in the Sea-water
			Agar		
1	Aug. 25	Aug. 26	1,700	almost en- tirely typhoid	water in the same case 585,000 per c.c.
2	"	"	"	"	
3	"	Aug. 27	7,020	"	water in the same case 468,000 per c.c.
4	"	Aug. 28	7,000	"	water in the same case 40,950 on agar, 5,200 gelatine per c.c.
5	Aug. 26	Aug. 29	455	"	
6	Aug. 28	Aug. 30	195	"	water in the same case 2,047,500 per c.c.
7	"	Sept. 4	390	"	
8	Aug. 31	"	325	"	
9	"	Sept. 10	455	"	

In the following series of experiments infected oysters were taken, the duplicates of which as seen in the preceding table contained comparatively large numbers of the *B. typhosus*, and were subjected to a running stream of pure sea-water. The result is definite and uniform, there is a great diminution or total disappearance of the *B. typhosus* in from one to seven days.

Table showing Organisms present after Washing.

Oyster	Inoculated	Washed	Examined	No. of Colonies	Kind of Organisms present
				Agar	
1	Aug. 25	Aug. 26	Aug. 30	80	2 colonies <i>B. typhosus</i>
2	"	Aug. 28	"	23	<i>B. typhosus</i> present
3	Aug. 26	"	"	44	" "
4	"	Aug. 29	"	40	" "
5	Aug. 27	"	"	5	" "
6	"	"	Aug. 31	700	abundant <i>B. typhosus</i>
7	Aug. 28	Aug. 30	"	55	<i>B. typhosus</i> present
8	Aug. 26	Aug. 28	Sept. 3	4	? <i>B. typhosus</i>
9	Aug. 27	Aug. 29	"	10	no <i>B. typhosus</i> found
10	"	"	"	8	3 colonies of <i>B. typhosus</i>
11	Aug. 28	Aug. 30	Sept. 4	4	1 colony of <i>B. typhosus</i>
12	"	Sept. 3	"	200	majority <i>B. typhosus</i>
13	Aug. 31	?	"	4	
14	Aug. 28	Sept. 3	Sept. 6	65	no <i>B. typhosus</i> , but <i>Proteus</i>
15	Aug. 31	"	"	5	? <i>B. typhosus</i>
16	"	Sept. 5	"	70	half of colonies <i>B. typhosus</i>
17	"	Sept. 3	Sept. 10	1	no <i>B. typhosus</i>
18	"	Sept. 5	Sept. 11	2	? <i>B. typhosus</i>

V.—The Green Colouration and "Green Disease" in Oysters.

We have continued our investigation of green oysters from various localities, including both the healthy green oysters grown at Marennes and other places on the West and North coasts of France, and in the Roach River in Essex, and also what we regard as the unhealthy oysters which show a pale greenness due to a leucocytosis. The green patches visible to the eye on the mantle of these oysters correspond to accumulations of the leucocytes

which in mass have a green tint. These cells are granular and amoeboid. The granules do not give any definite reaction with the aniline stains and so far we have not made out their precise nature.

Dr. Charles Kohn, at our request, has kindly made a further Chemical analysis of Oysters from various localities for us, and his results, as expressed in a paper he read on the subject at the British Association Meeting, are as follows:—*

“The early observations of Berthelot which showed that the green colour of French oysters (*‘huitres de Marennes’*) is not due to chlorophyll, but probably to iron have been recently extended by A. Chatin and A. Muntz (*Compt. Rend.*, 1892, cxviii. 17 and 56). From their analytical results these observers conclude that both the green and the brown colourations of various types of French oysters are due to the presence of iron, and that the depth of colour bears a close proportion to the quantity of iron contained. The colourations are chiefly apparent in the gills, but extend also to the labial palps and parts of the alimentary canal. Chatin and Muntz base their conclusions in the first place upon the fact that they find about twice as much iron in the gills as in the rest of the body of green oysters, and secondly upon the occurrence of a larger quantity of iron in the gills of green than of white oysters.

“The cause and origin of this colouration is a physiological problem of much interest, but the confirmation of Chatin and Muntz’ results also appeared of importance to Profs. Herdman and Boyce in connexion with their investigations on oysters and disease, and therefore the

*I beg to express my thanks to Dr. Kohn for his kindness in making these determinations for us, and for allowing me to incorporate his results in this report.

following experiments on the occurrence of copper as well as of iron in various kinds of oysters were undertaken at Professor Herdman's request. The point at issue is not so much the nature of the colouring matter, nor whether it does or does not contain iron, but simply whether the coloured parts of the green oysters contain proportionately such an excess of the metal that the colour can be attributed to its presence. This has not been found to be the case. The determination of the copper appeared to be of some interest, since poisonous effects have often been attributed to its presence, although earlier observers have shown that a small quantity is a normal constituent of the blood of the oyster.

“Electrolytic methods of analysis were adopted both for the determination of iron and copper; these methods I have already shown (Brit. Assoc. Reports, 1893, p. 726) possess marked advantages for the estimation of minute quantities of metal, especially if derived from organic matter, for they are quite free from any prejudicial influences traces of organic matter may exert, such as arise when volumetric or calorimetric methods are employed. In each determination the bodies or gills only of six oysters were carefully washed, dried between filter paper to remove as much adherent moisture as possible and then carefully dried in porcelain dishes in the air bath at 100° C. When this drying was as complete as possible, the oysters were heated in the air bath until thoroughly carbonised, the carbon carefully burnt off over the free flame and the residue finally ignited in a porcelain crucible. Special care was taken to exclude dust during both the drying and the ignition. The ash was then thoroughly extracted with a mixture of 25 c.c. hydrochloric acid and 25 c.c. sulphuric acid (1:2) on the water bath, and the resulting solution filtered and concentrated. The residue was free

from both copper and iron. The acid solution obtained was electrolysed for copper with the usual precautions, a spiral of fine platinum wire weighing about 5 grme. being employed as the cathode. The iron was determined in the residual solution, after neutralisation with ammonium hydrate, &c., acidifying with a few drops of oxalic acid solution, and boiling with ammonium oxalate. Four grme. of the oxalate were added in each case, the precipitated calcium oxalate (which is quite free from iron) filtered off and thoroughly washed and the resulting solution electrolysed, the metallic iron being also deposited on a spiral of platinum wire. A blank experiment with all the reagents employed was made and the amount of metal found (0·0002 grme. iron) deducted in each case. Also the deposited metal, both iron and copper, was dissolved off the electrode by acid, the solution obtained tested by the ordinary reagents and the spiral re-weighed, as a check upon the determinations since the quantities found were extremely small.

“The following table gives the results obtained, the iron being expressed in milligrammes per six oysters or gills of six oysters in each case, so that the weights given express the figures actually found.

I.—*Determination of Iron.*

Six Oysters	French “Huitres de Marennes”	Dutch	American
Gills only	0·6 mgrme.	0·4	2·3
Bodies minus gills	1·2	1·5	1·7

“From these figures it is evident that there is not an excessive quantity of iron in the gills of the green oysters, the proportion of iron in the gills as compared with the

rest of the body is somewhat more (1:2) than that found in Dutch oysters (1:3·7) but much less than in American oysters which are white (1·4:1). The comparison is purposely made on the absolute quantity of metal in the gills and the rest of the body, as any other basis for calculation is *fallacious*. Chatin and Muntz reckon on the weight of the dried organic matter present, but it was not found possible to get anything approaching constant weights in this way. This may to some extent account for the differences in our results, but I should also like to point out that although the ratio of iron in the gills and the rest of the body in green and in brown oysters is from 1:1·8 (feebly green) up to 1:2·3 (very green) they also instance white oysters with a proportion of 1:1·6. It is certainly somewhat strange that they find more iron in the gills than in the rest of the body in all cases, which is not the case in my own experiments. But the quantities of metal present are so small, that since they do not state how many oysters were taken for analysis and employ the permanganate method for the estimation of the iron, it is difficult to say what degree of absolute accuracy their results represent and therefore to judge in how far their analytical data justify their conclusions.

“From two points of view the above results show that the greenness of the gills of French oysters is certainly not due to iron:—

- (1) Because the gills of the green oysters contain less iron than the rest of the body;
- (2) Because the proportion of iron in the gills as compared with the rest of the body in white (American) oysters is greater than in the green.

“That the method is reliable is shown by two determinations of the iron in the gills of American oysters one giving 2·3 and the other 1·8 mgrme. of iron per six pairs

of gills. Variations in the size of the oysters will of course account for small differences, especially with the bodies.

II.—*Determination of Copper.*

Six Oysters	French. "Huitres de Marennes"	Dutch	American
Gills only	Trace	0·8	1·7
Bodies minus gills	2·4 mgrme.	1·4	3·3

"These results show that copper is present normally in both green and in white oysters in small quantity, but that the greenness of the gills of French oysters is certainly not due to this metal—in fact they contain only the merest trace.

"Experiments by Prof. Herdman on the feeding of oysters with very dilute saline solutions of iron and of copper salts entirely confirm these analytical data. Beyond a certain amount of post-mortem green staining the oysters did not acquire any green colour."*

Prof. Thorpe who examined some green oysters obtained by Dr. Bulstrode at Falmouth found that they contained a notable amount of Copper. Possibly, however, the copper, in this exceptional case supposed to be derived from copper mines, may be merely mechanically deposited in the oyster, and although present may not be the actual cause of the colour, as we found the living oyster would not become coloured from copper salts.

Since our report on oysters and disease was read before the British Association in September, a bulky Local Government Board Report Supplement by Dr. Thorne

* See, for further details our account of these experiments in last year's Report, p. 62.

Thorne, Dr. Bulstrode and Dr. E. Klein has appeared, the conclusions in which very largely agree with and support the results arrived at by Prof. Boyce and myself. Dr. Bulstrode independently corroborates our account of the "pale green" disease, which he has also met with.

Oysters are at present being much discussed by the public and are sometimes condemned upon what seem insufficient grounds. Under these circumstances I feel myself justified in drawing up the following remarks of a general nature, addressed to the public, upon :—

"Healthy and Unhealthy Oysters."

It is very important at the present juncture that the public should recognise—both in justice to our famous "Natives" and other fishery industries, and also for their own comfort and ease of mind—that although some oysters and other shellfish may be liable to convey disease, others, probably most of them, are a healthy and valuable food; not perhaps a necessity, but certainly in the case of some invalids and convalescents, and to the hard-driven brain worker, an important addition to the diet. The recent oyster scare, or rather succession of scares, must have inflicted an immense amount of injury upon the oyster trade, and have caused much uneasiness and alarm amongst consumers. We can scarcely doubt, however, that the result will be advantageous to all concerned in the end, if only the sanitary authorities and the oyster growers can be induced to act upon the information now being supplied from various laboratories as to the life-processes of the oyster and the possible connection with disease germs.

The strongly worded Local Government Board Report which appeared towards the end of 1896, containing reports by the Medical Officer and others, drew public attention to what had been previously known only to a

few investigators, viz., that some—by no means all—of our oysters and mussels are grown or kept under most insanitary conditions, and may when taken as food, without the necessary precautions, from unhealthy localities, cause disease or poisoning. Since the publication of this “Yellow book” there has been a certain amount of complaint, and even some indignant remonstrance from oyster producers, much inquiry on the part of the public, and some correspondence in scientific journals. It seems to me that a few points want to be clearly stated, and some conclusions drawn as to the future regulation of our shellfish trade.

In the first place, out of the various forms of human poisoning which can be caused by food, shellfish, under unhealthy conditions, may give rise to two which are very distinct from one another. They are:—1. Bacterial infection, due to the presence of actual living disease germs, derived presumably from sewage. 2. Intoxication with organic poisons developed in the body of the oyster or mussel.

We need scarcely consider the third possible case, poisoning by means of copper salts taken into the body of the shellfish from its environment, as this, if it ever occurs, must be very rare. All oysters contain a little copper in their blood, but not enough to do any harm.

We are left then with the two possible causes of disease—specific bacterial infection and organic poisons. If a case of typhoid arises from eating an oyster, then we suppose that oyster must have contained the living typhoid bacilli, and these must have reached the oyster from some previous case of typhoid—that is bacterial infection, and the disease only develops after the proper and considerable interval. If, on the other hand, more or less severe gastric derangement and other symptoms of

acute poisoning follow almost immediately after eating shellfish, usually mussels, that we suppose to be due to the toxic effect of an organic poison or ptomaine called mytilotoxine developed in the liver of the shellfish as the result of an unhealthy life and probably caused by microbes. The two causes are distinct, and their effects upon man are very different, but both are due in the long run to contamination of the water, and so to want of care in choosing suitable localities for our shellfish beds.

So it comes to this, if we can have our mussel beds and oyster farms and "layings" inspected by competent authorities, and certified by the Board of Trade or some sanitary authority as being in a healthy condition, we could eat our oysters with an easy mind, which would be an undoubted advantage both to consumers and "the trade." The only objections, I take it, that can be urged against such a plan of inspection are—First, What are we to do with foreign oysters—Dutch, French, or American? Some or all of them may be good, but we cannot ensure that they are reared in thoroughly sanitary conditions. In the second place, pure sea-water, free from any chance of sewage contamination, can no longer be found close to any of our large coast towns, and yet localities in our estuaries and in the immediate neighbourhood of large centres of population are, from obvious reasons, the most convenient places for fattening and storing oysters.

It is probable, then, that we must be satisfied with a compromise. We must be content with something less than absolute perfection. After all, we do not want—even if we could get it—an aseptic oyster. The rest of our food—our milk, our bread and cheese, our ham sandwiches, and so on—are teeming with germs, most of them harmless so far as we know, but some of them may be just as bad as any that can be in shellfish. If we were

to insist on breathing filtered air and eating nothing but sterile food washed down with antiseptic drinks, we should probably die of starvation or something worse, if we did not go mad first with the constant anxiety. Pasteur once started the interesting question, which is now being worked out, whether the life of a higher animal, such as man, is possible under absolutely aseptic conditions, free from all germs. Whether possible or not, it would certainly not be desirable. We probably owe more, on the whole, to micro-organisms than will counterbalance what we suffer from them.

Consequently, I would urge the exercise of common-sense by the public, and of moderation on the part of some sanitary reformers. By all means let us get our oyster beds as healthy as possible but do not insist upon conditions which will make it impossible to rear any oysters at all.

Professor Boyce and I, as the result of our work at this subject—oysters and disease—for the last two years, recommended a year ago (in the report for 1895 on the Lancashire Sea-Fisheries Laboratory) two sanitary measures—namely, 1st, the inspection of all grounds upon which shellfish are grown or bedded so as to ensure their practical freedom from sewage; and, 2nd, the use, when necessary, of what the French call *dégorgeoirs*—tanks of clean water, in which the oysters should be placed for a short time before they are sent to the consumer. I am inclined now to suggest that a combination of these two methods would be a practical and satisfactory solution of the present difficulty. The *dégorgeoirs* may be regarded as a precautionary measure of the nature of quarantine, to which oysters from foreign or unknown beds, or such as are suspected from any reason, should be subjected. Our experiments at University College have shown, as Professor

Boyce announced to the physiological section at the recent British Association meeting, that it is easy to get rid of bacterial infection by placing the shellfish in a stream of running water. When oysters were infected with typhoid, and were then placed in a series of vessels through which a stream of sea-water was kept running, it was found that there was a great diminution or total disappearance of the typhoid bacillus in from one to seven days. The water need not be sea-water (although that is *best*), but may be fresh-water with a little salt, as oysters frequently live in estuaries which are brackish, or, at times, almost wholly fresh; and I may add, for the comfort of troubled housekeepers, that a clean vessel in the pantry sink under the running tap is a very fair substitute for our more elaborate experimental apparatus, and that even one day makes a great deal of difference in the washing-out of the germs. I need scarcely say that the oysters must be alive. It is no use subjecting oysters that have been opened to this prolonged soaking. The essence of the “*dégorgement*” treatment is that the living animal purifies itself.

Authoritative inspection and licensing of the shellfish grounds would, no doubt, result in many beds being at once certified as quite healthy, and oysters from these might then be sold without restrictions, and consumed with peace of mind; a few localities, which are discussed in the Local Government Board Report, would be at once condemned as unsuitable to have any connection whatever with human food; while there would remain a number of spots in estuaries or near large towns where the conditions are not absolutely bad and are not wholly good, and oysters from such places should be subjected to the “*dégorgement*” treatment before being sold. One other simple piece of advice: The oyster ought to be obtained

as fresh as possible from the sea, or from moving water. It is not good for any animal—the oyster is like its consumer in this as in many other respects—to be shut up in a barrel or a sack for days or weeks, and if you put the oyster under unhealthy conditions, you will probably eat unhealthy oysters.

A careful consideration, then, of our own experiments, and of the evidence given in the recent Local Government Board Report and derived from other sources, leads us to the conclusion that what is indicated at the present time is that (1) some fisheries or sanitary authority should offer to inspect the beds, and certify as to their condition; (2) the oyster growers and merchants should unite in an effort to remove all grounds for suspicion by allowing biological as well as economical considerations to weigh with them in their choice of localities for “laying,” and (3) the public should not give way to unnecessary alarm. We cannot escape disease germs, and we probably all of us encounter them frequently without any consequences. Shellfish only share with milk, bread, cold meat, the water we drink, and the air we breathe the responsibility of occasionally being liable to convey disease to the human body, and that is no sufficient reason for avoiding what is otherwise healthy food. Common-sense on the part of the public, reform where necessary by the oyster trade, and regulation by some impartial authority, ought to enable us to feed on healthy oysters with an easy mind.

THE MARINE LABORATORY AT PIEL.

In the introduction to last year's report I alluded to the fitting up of a branch laboratory at Piel (Roa Island) in Barrow Channel. At first it was only proposed that the large boat house attached to the house known as Villa Marina should be made use of, and under these

circumstances, at the request of your Committee, in my capacity of Honorary Director of your Scientific work, I draw up the following suggested scheme of observations:—

“MEMORANDUM sent by W. A. Herdman to the Chairman of the Lancashire Sea-Fisheries Committee on August 19th, 1896, in regard to the uses that could be made of Bouchots, Lobster tank, and Branch Laboratory, Piel Island.

I. Bouchots.

“The chief object, it seem to me, of these experimental Bouchots is to enable us to institute a comparison between the two methods of rearing mussels:—on *Beds*, and on *Bouchots*. We already have the mussels growing in beds in our neighbourhood. What we want to know is:—

- (1) Can we usefully supplement the beds by Bouchots?
- (2) Can we erect Bouchots where beds will not flourish?
- (3) Can we raise and fatten the mussels *more rapidly* on the Bouchots than in the beds?

“In order to ascertain these points, Mr. Scott and the Bailiffs in the neighbourhood of Piel should familiarise themselves as thoroughly as possible with the conditions of the mussels, young and old, on the different parts of the beds, and should as far as possible ascertain the rate of growth on the different parts of different beds. Then samples of young mussels of different ages, some very young, others half grown, should be put in the wattling on the Bouchots, and carefully observed from time to time, and samples should be opened say once a month in order to ascertain their condition and rate of growth. In this way a direct comparison could be instituted between the Bouchot grown mussels and those on the beds.

II. The Lobster Tank.

“The first object ought to be to see whether full grown lobsters will live healthily in the tank. That is being ascertained at present. Several lobsters are now in the tank and are being watched and fed.

“The second point is to determine whether adult lobsters will breed in the pond, and whether the females “in berry” will not only live but will manage to keep their developing embryos alive up to the period of hatching, in captivity.

“When all that has been ascertained by experiment, I should recommend that a further very important step be taken, and that we try to secure and rear the young lobsters hatched out from the eggs of the adult females. That I think can be done by placing the parent lobster for a few days at the time when the young are hatching out in wire gauze cages from which the young can be removed and transferred to tanks in the Piel laboratory. Further experiments will then have to be tried as to the conditions of water and feeding under which these young lobsters can be kept healthy and reared in captivity.

III. The Branch Laboratory at Piel.

“It seems to me that the most useful purposes to which this work room can be put are—

- (1) to enable Mr. Scott and the Bailiffs to examine in the fresh condition the samples of mussels and other shellfish taken from the neighbouring beds.
- (2) The tanks under cover in the Laboratory should be used for rearing the young lobsters when these have been hatched out in the lobster pond on the shore.
- (3) The Piel laboratory would be suitable for trying the effect upon living shellfish—oysters, mussels,

and cockles—of various fluids, such as fresh-water, water from docks, and discharges from chemical works, which are known or supposed to find their way to the shellfish beds.

- (4) I should propose that early next spring, as soon as the Sea-Fisheries steamer is able to obtain for us the necessary spawning fish, Mr. Scott should try, in the Piel laboratory, the same experiments in the hatching of edible sea-fish which were successfully carried out last Easter at Port Erin."
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Since this memorandum was prepared, however, a wider scheme has developed involving the conversion of the villa itself into a Marine Laboratory both for Fisheries Observations and Scientific Research. As the details of that scheme are now under consideration it would be premature to discuss them in the present report. I have no doubt that the results of the work carried on at the Piel Marine Laboratory will figure largely in our future reports, and will have an important influence on the scientific development of the Lancashire Sea-Fisheries.

EXPLANATION OF THE PLATES.

PLATE I.

Figure of the Tanks, Water-wheel, and other apparatus used in the Fish-Hatching experiment at Port Erin.

PLATE II.

Fig. 1. Egg of Lemon Sole 18 hours after being fertilised.

Fig. 2. " " 42 " "

Fig. 3. " " 66 " "

Fig. 4. Egg of Lemon Sole 90 hours after being fertilised.

Fig. 5. " " 114 " "

Fig. 6. " " 138 " "

Fig. 7. " " 162 " "

Fig. 8. " " 186 " "

at the point of hatching.

Fig. 9. Egg of Witch 168 hours after being fertilised ; at
the point of hatching.

Fig. 10. Newly hatched Witch, ventral view.

PLATE III.

Fig. 1. Egg of Witch 18 hours after being fertilised.

Fig. 2. " " 42 " "

Fig. 3. " " 66 " "

Fig. 4. " " 90 " "

Fig. 5. " " 114 " "

Fig. 6. " " 138 " "

Fig. 7. " " 162 " "

Fig. 8. " " 186 " "

Just previous to hatching out.

Fig. 9. Egg of Witch 186 hours after being fertilised.
Just previous to hatching out.

Fig. 10. Newly hatched Witch, lateral view.

PLATE IV.

Fig. 1. Egg of Grey Gurnard 18 hours after being fertilised.

Fig. 2. " " 42 " "

Fig. 3. " " 66 " "

Fig. 4. " " 90 " "

Fig. 5. " " 114 " "

Fig. 6. " " 138 " "

Fig. 7. " " 162 " "

Fig. 8. " " 186 " "

Fig. 9. " " 190 " "

Fig. 10. " " 190 " "

APPENDIX :—

CATALOGUE of the “ FISHERIES COLLECTION ”

IN THE

ZOOLOGICAL DEPARTMENT, UNIVERSITY COLLEGE, LIVERPOOL.

THIS “ Fisheries Collection,” formed to illustrate the Sea-Fisheries of Liverpool Bay and the neighbouring parts of the Irish Sea, was commenced a few years ago in connection with the Lancashire Sea-Fisheries Laboratory at University College. It was largely added to for the purpose of illustrating the Fisheries lectures given, under the auspices of the Lancashire and Cheshire Sea-Fisheries Committee, at University College in the summer of 1895; and by the addition of specimens collected for the Reports issued upon Oyster and other shell-fish culture. It has now been re-arranged and catalogued on being transferred to the new Museum generously given by the late Mr. George Holt to the Zoological Department of University College.

In the practical work of forming and arranging the Collection I have received much help from Mr. Andrew Scott, Fisheries Assistant to the Committee.

Some of the specimens, photographs and diagrams have already been used for Fisheries lectures; and now, in this more complete condition, in the new building, it is hoped that the Collection will prove of much service in connection with lectures, demonstrations, and other forms of technical instruction both to Fishermen and others.

It is probably as important for the future of Fisheries investigation and improvement, and of just legislation in regard to the Fisheries, that the general public should

have opportunities of learning and realising the truth in regard to the habits and life-histories of food fishes, and the inter-relations of animals in the sea, as it is that the fisherman himself should be instructed in such matters.

In addition to public lectures, the establishment in each sea-fisheries district of a technical museum, or collection illustrating the local fish and fisheries, showing the spawn and other stages in the life-history of the various fishes, their foods, their parasites, their diseases, and so forth, is an important method by which an educated public opinion upon Fishery questions can be formed. Such a collection would also be available for consultation on detailed points by fishermen, fish-salesmen, fishery officers, and members of Sea-Fisheries Committees in the district; and would probably be of interest to fisheries experts from other parts of the country and from abroad who may desire information as to our local industries and the conditions under which they are carried on.

W. A. HERDMAN.

JULY, 1896.

JANUARY, 1897:—This Catalogue is now reprinted, with some additions and corrections, for the use of the Lancashire Sea-Fisheries Committee.

W. A. H.

FISHERIES COLLECTION.

MOST of the animals in the sea which form the object of our Local Fisheries belong to one or other of three great groups, viz. :—

- I. PISCES.—Fishes properly so-called (Cod, Herring, &c.)—Vertebrate or Back-boned animals with fins and scales, but no shell.
 - II. MOLLUSCA.—Shell-fish—(Oyster, Mussel, &c.)—Animals with no back-bone and no limbs; the soft unjointed body is enclosed in a hard shell.
 - III. CRUSTACEA.—Legged Shell-fish (Lobster, Crab, Shrimp, &c.)—Animals with no backbone, but with legs, feelers, and other limbs; the jointed body has an outer hard covering.
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In addition to these direct objects of the Fisherman's work there are many other groups of animals in the sea which, although not themselves edible, are of very great importance to the Fishing industries, and must not be neglected by those who would form a correct opinion on the feeding and breeding of our marketable fish. Many of the inedible lower (invertebrate) animals are of immense importance as the food, or the food *of the food*, of edible fish. Others are parasites or act injuriously, directly or indirectly, at some time in the life-history, upon food fishes—this includes such cases as the competition between non-marketable fish such as the Solenette and marketable fish of similar habits.

The arrangement of the series of specimens in this collection is as follows :—

- A. The Series of Fishes of the district—whether edible or not.
 - B. Series showing the Reproductive Organs, the Spawn, and the young stages in the development and life-history of Fishes from the Egg onwards.
 - C. Series of Foods of various fishes, both young and old.
 - D. Series of Fish Parasites—internal and external.
 - E. Other Enemies of Fishes.
 - F. Collection showing Diseases or abnormal conditions of Fishes.
 - G. Collection of Edible Shell-fish of our district.
 - H. Collection illustrating Oyster culture in France, Holland and other countries.
 - I. Collection of Edible Crustacea.
 - K. Collection of Sea-bottoms and other submarine deposits.
 - L. Collection of Natural Baits used in the Fisheries.
 - M. Collection of Models of fishing implements, of apparatus for fish culture, and hatching, and of shell-fish cultivation.
 - N. Series of Photographs and Lantern Slides illustrating the Lancashire Sea-Fisheries District.
 - O. Collection illustrating the Regulations of Sea-Fisheries Committees and other Authorities.
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A.—Collection of Fishes of the District, arranged Zoologically.

Class :—PISCES.—THE TRUE FISHES.

The Fishes are back-boned animals, living in water, with cold blood, and breathing by means of gills placed at the sides of the throat; the limbs are in the form of fins, and the skin is generally covered with scales; a row of sense-organs along each side of the body forms a conspicuous "lateral line."

With the exception of the Mud-fishes (Dipnoi) which are not marine, and do not occur in Europe, all the great groups (Teleostei, Ganoidei, Elasmobranchii and Cyclostomata) are represented in our district. Some members of all the groups of fishes are edible, but by far the most important groups from the economic point of view are the Teleostei and the Elasmobranchii, and especially the former.

Sub-class I.—TELEOSTEI.—THE BONY FISHES.

With well developed jaws, fins, and scales; with a bony skeleton, having completely formed vertebræ, no spiral valve in the intestine, tail evenly lobed externally, gills free on gill arches underneath a gill cover; air bladder generally present.

Order ACANTHOPTERYGII.

With stiff, unjointed spines in the fins; the air ladder has no duct.

Family SPARIDÆ.

Pagellus centrodontus, De la Roche (Day,* vol. I., p. 36, pl. XIII.). The common sea bream.

Family COTTIDÆ.

Cottus scorpius, Linn. (Day, vol. I., p. 49, pls. XIX. and XX.). The sea-scorpion.

Cottus bubalis, Euphrasen (Day, vol. I., p. 51, pl. XX.).
The father lasher.

Trigla hirundo, Linn. (Day, vol. I., p. 59, pl. XXIV.).
The yellow gurnard.

Trigla gurnardus, Linn. (Day, vol. I., p. 62, pl. XXV.).
The common gurnard.

Family CATAPHRACTI.

Agonus cataphractus, Linn. (Day, vol. I., p. 67, pl. XXVIII.). The pogge.

Family PEDICULATI.

Lophius piscatorius, Linn. (Day, vol. I., p. 73, pl. XXIX.). Angler or devil-fish.

Family TRACHINIDÆ.

Trachinus vipera, Cuv. (Day, vol. I., p. 81, pl. XXXI.).
Lesser weever or sting-fish.

Family SCOMBRIDÆ.

Scomber scomber, Linn. (Day, vol. I., p. 83, pl. XXXII. and XXXIII.). The mackerel.

Family CYTTIDÆ.

Zeus faber, Linn. (Day, vol. I., p. 138, pl. XLVIII.).
The John Dory.

Family GOBIIDÆ.

Gobius ruthensparri, Euphr. (Day, vol. I., p. 160, pl. LII.). The two-spotted goby.

* Under each species a reference is given to the vol., page, and plate in Day's Fishes of Great Britain, the work most generally consulted on the subject.

Gobius minutus, Gmel. (Day, vol. I., p. 165, pl. LII.).

The freckled goby.

Gobius quadrimaculatus, Cuv. and Val. (Day, vol. I., p. 168, pl. LIII.). The four-spotted goby.

Family CALLIONYMIDÆ.

Callionymus lyra, Linn. (Day, vol. I., p. 174, pl. LIV.).

The dragonet.

Family DISCOBOLI.

Cyclopterus lumpus, Linn. (Day, vol. I., p. 180, pl. LV.).

Lump-sucker or hen-fish.

Liparis vulgaris, Linn. (Day, vol. I., p. 184, pl. LVI.).

The sea snail.

Liparis montagui, Donovan, (Day, vol. I., p. 184, pl.

LVI.). Diminutive lump-sucker.

Family GOBIESOCIDÆ.

Lepadogaster gouanii, Lacép. (Day, vol. I., p. 189, pl.

LVII.). The cornish sucker.

Lepadogaster bimaculatus, Donovan (Day, vol. I., p.

192, pl. LVII.). The doubly-spotted sucker.

Family BLENNIIDÆ.

Blennius pholis, Linn. (Day, vol. I., p. 203, pl. LX.).

The shanny.

Blennius ocellaris, Linn. (Day, vol. I., p. 201, pl. LIX.).

The butterfly blenny.

Carelophus ascanii, Walbaum (Day, vol. I., p. 206, pl.

LX.). Yarrell's blenny.

Centronotus gunnellus, Linn. (Day, vol. I., p. 208, pl.

LXI.). The butter-fish.

Family GASTEROSTEIDÆ.

Gasterosteus spinachia, Linn. (Day, vol. I., p. 246, pl.

LXVIII.). The fifteen-spined stickleback.

Family LABRIDÆ.

Labrus mixtus, Fries och Ekstrom (Day, vol. I., p. 256,

pl. LXXII.). The cook wrasse.

Centrolabrus exoletus, Linn. (Day, vol. I., p. 267, pl. LXXVI.). The rock cook.

Order ANACANTHINI.

There are no spines; the fin rays are soft, and jointed; the ventral fins if present are far forward; the air bladder if present has no duct.

Family GADIDÆ—the Cod family.

One of the most important families of fishes from the economic point of view.

Gadus morrhua, Linn. (Day, vol. I., p. 275, pl. LXXVIII.).

The cod—probably the most useful of all fish to man. No part of the body seems valueless. In addition to its prime importance as a food, oil is extracted from the liver, the head, tongue and sounds can be made to form a good article of food, the offal and bones when steamed, dried and ground up are converted into very good manure said to be equal as a fertilizer to Peruvian guano, the roe is a splendid bait used in the sardine fisheries of France and Spain, and from the swim-bladder isinglass is made.

Gadus æglefinus, Linn. (Day, vol. I., p. 283, pl. LXXIX.). The haddock.

Gadus minutus, Linn. (Day, vol. I., p. 288, pl. LXXXI.).
The power cod.

Gadus merlangus, Linn. (Day, vol. I., p. 290, pl. LXXXII.). The whiting.

Gadus luscus, Willughby (Day, vol. I., p. 286, pl. LXXX.).
The bib.

Gadus pollachius, Linn. (Day, vol. I., p. 296, pl. LXXXIII.). The pollack.

Merluccius vulgaris, Cuv. (Day, vol. I., p. 300, pl. LXXXV.). The hake.

Molva vulgaris, Flem. (Day, vol. I., p. 305, pl. LXXXVI.). The ling.

Lota vulgaris, Cuv. (Day, vol. I., p. 308, pl. LXXXVII.). The burbot.

Motella mustela, Linn. (Day, vol. I., p. 314, pl. LXXXVIII.). The five-bearded rockling.

Family OPHIDIIDÆ.

Ammodytes lanceolatus, Lesauv. (Day, vol. I., p. 329, pl. XCII.). The greater sand-eel.

Ammodytes tobianus, Linn. (Day, vol. I., p. 331, pl. XCII.). The lesser sand-eel.

Family PLEURONECTIDÆ—the flat fishes.

A very important family of food fishes. The symmetry is so disturbed in the adult that both eyes are placed on one, the coloured, side of the body, which is uppermost as the fish lies on the sea-bottom.

Hippoglossoides limandoides (Day, vol. II., p. 9, pl. XCV.). Long rough dab.

Rhombus maximus, Linn. (Day, vol. II., p. 11, pl. XCVI.). The turbot.

Rhombus lævis, Rondel. (Day, vol. II., p. 14, pl. XCVII.). The brill or brett.

Rhombus norvegicus, Günther (Proc. Roy. Soc. Edin., vol. XV. (1889), p. 217, pl. IV., fig. C.).

The Norway top-knot.

Zeugopterus unimaculatus, Risso (Day, vol. II., p. 16, pl. XCIX.). Bloch's topknot.

Zeugopterus punctatus, Bloch (Day, vol. II., p. 18, pl. C.). Müller's topknot.

Arnoglossus megastoma, Donovan (Day, vol. II., p. 21, pl. XCVIII.). The sail fluke.

Arnoglossus laterna, Walb. (Day, vol. II., p. 22, pl. XCIX.). The megrim.

Pleuronectes platessa, Linn. (Day, vol. II., p. 26, pl. CI.). The plaice.

Pleuronectes microcephalus, Donovan (Day, vol. II., p. 28, pl. CII.). Lemon-sole.

Pleuronectes cynoglossus, Linn. (Day, vol. II., p. 30, pl. CIII.). The witch.

Pleuronectes limanda, Linn. (Day, vol. II., p. 31, pl. CIV.). The dab.

Pleuronectes flesus, Linn. (Day, vol. II., p. 33, pl. CV.). The flounder.

Solea vulgaris, Quensel (Day, vol. II., p. 38, pl. CVI.). The sole.

Solea variegata, Donovan (Day, vol. II., p. 43, pl. CVIII.). The variegated sole.

Solea lutea, Risso (Day, vol. II., p. 44, pl. CVIII.). The solenette.

Order PHYSOSTOMI.

Fin rays jointed, ventral fins, if present, far back; air bladder, if present, has a duct.

Family SALMONIDÆ.

Argentina sphyrena, Linn. (Day, vol. II., p. 136, pl. CXXV.).

[Fresh water Salmonidæ omitted].

Family SCOMBRESOCIDÆ.

Belone vulgaris, Willughby (Day, vol. II., p. 147, pl. CXXVII.). The garfish.

Family CLUPEIDÆ, the Herring tribe.

A very important family of food fishes.

Clupea harengus, Linn. (Day, vol. II., p. 208, pl. CXXXVIII.). The herring.

Clupea sprattus, Linn. (Day, vol. II., p. 230, pl. CXXXIX.). The sprat.

Family MURÆNIDÆ.

Anguilla vulgaris, Turt. (Day, vol. II., p. 241, pl. CXLII.). The eel.

Conger vulgaris, Cuv. (Day, vol. II., p. 250, pl. CXLII.).
The conger.

Order LOPHOBANCHII.

Strong bony plates covering surface; with a long snout having the small toothless mouth at its end; gills in little tufts; air bladder with no duct.

Family SYNGNATHIDÆ—pipe fishes.

Siphonostoma typhle, Linn. (Day, vol. II., p. 257, pl. CXLIV.). The broad-nosed pipe fish.

Syngnathus acus, Linn. (Day, vol. II., p. 259, pl. CXLIV.). The great pipe-fish.

Nerophis lumbriciformis, Willughby (Day, vol. II., p. 263, pl. XLIV.). The worm pipe-fish.

Sub-class II.—GANOIDEI.

With bony plates on the surface of the body. One actual gill opening on each side under gill cover. Air bladder with duct. Spiral valve.

Family ACIPENSERIDÆ.

Acipenser sturio, Linn. (Day, vol. I., p. 280, pl. CL.).
The sturgeon.

Sub-class III.—ELASMOBRANCHII.

SHARKS, DOGFISH, RAYS AND SKATES.

With a cartilaginous skeleton and an unevenly lobed tail. The gills are in separate pouches opening by separate gill slits on the sides or lower surface of the throat, there is no gill cover; no air bladder. The eggs are large and few in number. The large mouth, armed with numerous teeth, is on the lower surface of a prominent snout.

Family CARCHARIIDÆ—Sharks.

Galeus vulgaris, Flem. (Day, vol. II., p. 292, pl. CLIII.).

The tope.

Mustelus vulgaris, Müller and Henle (Day, vol. II., p. 295, pl. CLV.). The smooth-hound.

Family LAMNIDÆ—Dogfish.

Lamna cornubica, Gmel. (Day, vol. II., p. 297, pl. CLVI.). The Porbeagle or Beaumaris shark.

Family SCYLLIIDÆ.

Scyllium canicula, Linn. (Day, vol. II., p. 309, pl. CLIX.). The spotted dog-fish.

Pristiurus melanostomus, Rafin. (Day, vol. II., p. 314, pl. CLX.). The black-mouthed dog-fish.

Family SPINACIDÆ.

Acanthias vulgaris, Risso. (Day, vol. II., p. 315, pl. CLX.). The picked-dog.

Family RHINIDÆ.

Rhina squatina, Linn. (Day, vol. II., p. 326, pl. CLXIII.). Angel-fish or Monk.

Family RAIIDÆ—the Skates.

Raia batis, Linn. (Day, vol. II., p. 336, pl. CLXVI.).
The blue skate.

Raia clavata, Linn. (Day, vol. II., p. 343, pl. CLXXI.).
The thornback.

Raia maculata, Montagu (Day, vol. II., p. 345, pl. CLXXII.). The spotted-ray.

Raia radiata, Donovan (Day, vol. II., p. 347, pl. CLXXIII.). The starry-ray.

Raia circularis, Couch (Day, vol. II., p. 348, pl. CLXXIV.).
The cuckoo-ray.

Sub-class IV.—CYCLOSTOMATA.

Mouth sucker-like, skeleton cartilaginous, no complete

vertebræ in back bone, no ribs and no developed jaws, no limb-fins; gills in separate sacks on sides of body.

Family PETROMYZONTIDÆ, Lampreys.

Petromyzon fluviatilis, Linn. (Day, vol. II., p. 359, pl. CLXXXIX.). Silver lamprey.

B.—Series showing the Reproductive Organs, the Spawn, and the young stages in the development and life-history of some fishes from the Egg onwards.

B. I. SERIES OF OVARIES AND TESTES (hard and soft roe).

1. Ovaries (hard roe) of mature whiting (*Gadus merlangus*).
2. Testes (soft roe) of mature whiting.
3. Ovaries (hard roe) of mature haddock (*Gadus æglefinus*).
4. Testes (soft roe) of mature haddock.
5. Ovaries of mature herring (*Clupea harengus*).
6. Testes of mature herring.
7. Ovary and oviducts of skate (*Raia batis*).
8. Dissection of plaice (*Pleuronectes platessa*) showing immature reproductive organs.
9. Dissection of plaice showing mature reproductive organs.

B. II. SERIES OF MATURE OVARIAN EGGS.

1. Eggs from the ovary of cod (*Gadus morrhua*).
2. ,, ,, whiting (*G. merlangus*).
3. ,, ,, haddock (*G. æglefinus*).
4. ,, ,, hake (*Merluccius vulgaris*).
5. ,, ,, grey gurnard (*Trigla gurnardus*).

6. Eggs from the ovary of blenny (*Blennius*, sp.).
7. ,, ,, lumpsucker (*Cyclopterus lumpus*).
8. ,, ,, sole (*Solea vulgaris*).
9. ,, ,, plaice (*Pleuronectes platessa*).
10. ,, ,, dab (*P. limanda*).
11. ,, ,, lemon sole (*P. microcephalus*).
12. ,, ,, witch (*P. cynoglossus*).
13. ,, ,, flounder (*P. flesus*).
14. ,, ,, topknot (*Zeugopterus unimaculatus*).

B. III. SERIES OF DEMERSAL EGGS—those that are found on the sea-bottom.

1. Eggs of blenny (*Blennius*, sp.).
2. ,, goby (*Gobius minutus*).
3. ,, lumpsucker (*Cyclopterus lumpus*).
4. ,, herring (*Clupea harengus*).
5. ,, skate (*Raia batis*).
6. ,, skate (*Raia* sp. ?).
7. ,, small spotted dogfish (*Scyllium canicula*).
8. ,, nurse-hound (*Scyllium catulus*).

B. IV. SERIES OF PELAGIC EGGS—those that float in the water.

1. Gathering from tow-net. "Hole." March, 1896.
2. ,, ,, ,, ,,
3. ,, ,, Off the Calif, January, 1893.
4. ,, ,, Off Morecambe Bay Lt. Ship, March, 1895.

B. V. SERIES OF DEVELOPING EMBRYOS (inside the egg-covering) of some food fishes. Hatched at Port Erin, April, 1896.

1. Embryos of lemon sole (*Pleuronectes microcephalus*): 66 hours.
2. Embryos of lemon sole (*Pleuronectes microcephalus*): 96 hours.
3. " " " " 112 "
4. Newly hatched lemon soles (*Pleuronectes microcephalus*).
5. Ova of witch (*Pleuronectes cynoglossus*): 66 hours.
6. " " " " 168 "
7. Newly hatched witches "
8. Ova of grey gurnard (*Trigla gurnardus*): 66 hours.
9. " " " " 114 "
10. Embryo skate (*Raia batis*).

B. VI. SERIES OF LARVAL FISHES.

1. Larvæ of lemon sole (*Pleuronectes microcephalus*).
2. " witch (*Pleuronectes cynoglossus*).
3. " Goby (*Gobius minutus*).
4. " plaice (*Pleuronectes platessa*).

B. VII. SERIES OF POST-LARVAL AND YOUNG FISHES.

1. Young plaice (*Pleuronectes platessa*) from $\frac{1}{4}$ inch to 3 inches in length.
 2. Young cod (*Gadus morrhua*).
 3. Young lumpsucker (*Cyclopterus lumpus*).
 4. Young yellow gurnard (*Trigla hirundo*).
 5. Young herring (*Clupea harengus*).
 6. Young worm-pipe fish (*Nerophis lumbriciformis*).
 7. Young butter-fish (*Centronotus gunnellus*).
 8. Young sea snail (*Liparis*, sp. ?).
 9. Young solenette (*Solea lutea*).
-

C.—Series of Foods of various fishes, both young and old.**C. I. FOODS FOUND IN THE STOMACHS OF ADULT FISHES.**

1. Food from stomach of cod (*Gadus morrhua*).
2. " " whiting (*Gadus merlangus*).
3. " " herring (*Clupea harengus*).
4. " " dragonet (*Callionymus lyra*).
5. " " pogge (*Agonus cataphractus*).
6. " " plaice (*Pleuronectes platessa*).
7. " " dab (*Pleuronectes limanda*).
8. " " solenette (*Solea lutea*).

C. II. FOODS FROM STOMACHS OF YOUNG FISHES.

1. Food from the stomach of Plaice ($2\frac{1}{8}$ inch).
2. " " " ($2\frac{3}{4}$ ").
3. " " " (small).
4. " " " (small).
5. " " Dab (2 inches).
6. " " Flounder ($5\frac{3}{4}$ inches).
7. " " Sole ($4\frac{1}{2}$ inches).

C. III. ANIMALS AND PLANTS WHICH ARE IMPORTANT FISH FOODS IN OUR DISTRICT.

- CRUSTACEA.
1. Spider crab (*Hyas coarctatus*). Food of cod, gurnard, skate.
 2. Shore crab (*Carcinus maenas*). Food of cod, skate.
 3. Swimming crab (*Portunus depurator*). Food of cod, whiting, haddock, dab, skate.
 4. Hermit crab (*Pagurus bernhardus*). Food of cod, whiting, haddock, dab, skate.

- CRUSTACEA. 5. Larval crabs (various species). Food of many young fishes.
6. Shrimp (*Crangon vulgaris*). Food of cod, whiting, haddock, gurnard, brill, sole, plaice, &c.
7. Shank (*Pandalus annulicornis*). Food of cod.
8. Crayfish (*Nephrops norvegicus*). Food of skate, &c.
9. Fairy shrimp (*Mysis vulgaris*). Food of cod, whiting, gurnard.
10. *Boreophausia raschii*. Food of herring, &c.
11. Isopods (*Idotea* sp.). Food of cod, whiting, plaice.
12. Sand hoppers (*Gammarus* sp.). Food of cod, whiting, gurnard, sole, plaice, skate.
13. Cumacea (*Diastylis* sp.). Food of cod, whiting, gurnard, sole, solenette, plaice.
14. Copepoda (various species). Food of very many young fishes; Herring also feed largely upon copepoda and schizopoda.

- MOLLUSCA. 1. *Tellina balthica*.
Food of Plaice, Dab.
2. *Scrobicularia alba*.
Food of Haddock, Plaice, Dab.
3. *Mactra stultorum*, and *M. elliptica*.
Food of Haddock, Plaice, Dab, Flounder.
4. *Donax anatina*.
Food of Plaice.

- MOLLUSCA. 5. *Philine aperta*.
Food of Haddock, Plaice, Dab.
6. Mussels (*Mytilus edulis*).
Food of Plaice, Dab.
7. Cockles (*Cardium edule*).
Food of Plaice, Dab.
8. Nudibranchs (*Doris* sp.).
Food of Dab.
- ECHINODERMATA. 1. Sand stars (*Ophioglypha albida*).
Food of Dab, Gurnard, Haddock.
2. Brittle stars (*Ophiothrix fragilis*).
Food of Cod.
3. *Echinocyamus pusillus*.
Food of Haddock.
4. Holothurians.
Food of Cod.
- ANNELIDA. 1. Rock worm (*Nereis* sp.).
Food of Sole, Lemon Sole, Plaice.
Dab, Flounder, Skate.
2. Lug worm (*Arenicola piscatorum*).
Food of Flat fishes.
- EMBRYOS and LARVÆ, of Various Animals. Food of many very young fishes.
- PLANTS. 1. Diatoms.
Food of some very young fishes.
2. Algæ.
Food of some Flat fishes.
-

D.—Collection of Fish parasites.

D. I. INTERNAL PARASITES.

1. Nematode Worms from the body cavity of the
Cod (*Gadus morrhua*).
2. „ „ whiting (*Gadus merlangus*).
3. „ „ herring (*Clupea harengus*).
4. „ „ sprat (*Clupea spratta*).
5. „ „ pogge (*Agonus cataphractus*).
6. „ „ sea-scorpion (*Cottus scorpius*).
7. „ „ plaice (*Pleuronectes platessa*).
8. „ „ dab (*Pleuronectes limanda*).
9. „ „ dog-fish (*Scyllium canicula*).
10. Tape worm from a Salmon (*Salmo salar*) caught
in the Dee.

D. II. EXTERNAL PARASITES.

1. *Caligus rapax*, from the cod (*Gadus morrhua*).
2. *Caligus curtus*, „ „
3. *Lepeoptheirus pectoralis*, from the plaice (*Pleuronectes platessa*), &c.
4. *Lepeoptheirus hippoglossi*, from the Holibut.
5. *Lerneonema spratta*, from the eye of the sprat
(*Clupea spratta*).
6. *Lerne branchialis*, from the gills of cod, &c.
7. *Chondracanthus merluccii*, from the gills of the
hake (*Merluccius vulgaris*).
8. *Chondracanthus lophii*, from the angler fish
(*Lophius piscatorius*).
9. *Lernæopoda galei*, from the dog-fish (*Scyllium
canicula*).
10. *Lernæopoda elongata*, from the eye of the
Greenland Shark (Iceland, R. L. Ascroft).
11. *Anchorella uncinata*, from the cod, &c.

12. *Pontobdella muricata* (the skate leech), from skate.
 13. *Myxine glutinosa*, hag fish.
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E.—Collection of other enemies to Fish.

1. Voracious fish, example the angler (*Lophius*).
 2. „ „ dog-fish (*Scyllium*).
 3. Sea-birds, example the Cormorant
 4. Sea-mammal, example the porpoise (*Phocæna*).
 5. Arrow-worm (*Sagitta*): (eats larval fishes).
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F.—Collection showing diseases or abnormal conditions of Fishes.

1. Reversed solenette.
 2. „ sole.
 3. „ flounder.
 4. Dab with tumours on colourless side.
 5. Trout with abnormal tail.
 6. Salmon attacked by fungus (*Saprolegnia ferox*).
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G.—Collection of Edible Shell-fish.

G. I. COCKLES (*Cardium edule*).

a. Marketable Cockles of our district.

1. Sample from Hilbre.
2. ,, Hoyle Bank.
3. ,, Crosby.
4. ,, Southport.
5. ,, St. Annes.
6. ,, Fleetwood.
7. ,, Cockerham Sands.
8. ,, Morecambe.
9. ,, Grange over Sands.
10. ,, Flookburgh Sands.
11. ,, Baicliff.
12. ,, Duddon.

b. Series of young cockles from $\frac{1}{8}$ th to 1 inch in length.

c. Pair of cockles showing over and just under marketable size, 2 inches by $\frac{3}{4}$ inch.

d. Brown cockles from Duddon cockle beds. The colour is due to an oxide of iron.

e. Cockles with tuft of Alga attached to the posterior margin of the shell, which lies uppermost in the sand.

f. Large cockles from the Barra Beds, Scotland.

G. II. MUSSELS (*Mytilus edulis*).

a. Marketable Mussels of our district.

1. Sample from Hilbre.
2. ,, Hoyle Bank.
3. ,, Wallasey.
4. ,, Southport.
5. ,, St. Annes.

6. Sample from Sunderland Point.
7. „ Morecambe.
8. „ Humphrey Head.
9. „ Roosebeck Scars.
10. „ Barrow Channel.
11. „ Barrow Rock.
12. „ Duddon (Scarfhole).
- b. Series of young mussels ranging from $\frac{1}{8}$ th inch to 1 inch in length.
- c. Pair of mussels just over and just under marketable size ($2\frac{1}{4}$ inch).
- d. Clump of mussels showing attachment by "byssus," as in beds.
- e. Young mussels attached to the abdominal appendages (swimmerets) of the common lobster (from H. Isaac, Esq.).

G. III. OYSTERS (*Ostrea edulis*).

- a. Natives from different parts of our own district.
 1. Bangor.
 2. Off Morecambe Bay Ship.
 3. Port Erin.
 4. Irish Sea.
 5. Fleetwood Deep Sea Oysters.
- b. Other British oysters.
 1. Colchester natives (from the Pyefleet).
 2. Roach River natives.
 3. Whitstable natives.
 4. Arkloes from Ireland.
 5. Pandores from Firth of Forth.
 6. Rock oyster from West coast of Scotland.
- c. Foreign European oysters.
 1. French oysters from Arcachon.
 2. „ „ „ Cancale.

3. French oysters from Marennes.
4. " " "
5. Italian oysters from Lake Fusaro.
6. " " "
7. Dutch oysters from Ierseke, Zeeland.
8. " " "
9. Belgian oysters from Nieuport.
10. Portuguese oysters (*Ostrea angulata*),
 grown at Arcachon, &c.
- d. American oysters (*Ostrea virginica*).
 1. Blue points.
 2. East Rivers.
 3. Sounds.
 4. American oysters bedded at Fleetwood.
 5. " " in Menai Straits.
 6. " " at Carlingford.
 7. " " at Cleethorpes.
 8. " " at Brightlingsea.
 9. Young American oysters on sole of old
 rubber shoe (from T. G. Musson, Esq.).

G. IV. OTHER SHELL-FISH OCCASIONALLY, OR LOCALLY,
 USED FOR FOOD.

a. In this country:—

1. The borer, *Pholas crispata*.
2. The gapers, *Mya truncata* and *Mya arenaria*.
3. The razor-fish, *Solen siliqua*.
4. *Lutraria elliptica*.
5. *Cyprina islandica*.
6. *Pectunculus glycimeris*.
7. The horse mussel, *Mytilus modiolus*.
8. The large scallop, *Pecten maximus*.

9. The common scallop or queen, *Pecten opercularis*.
 10. The limpet, *Patella vulgata*.
 11. The ear-shell, *Haliotis tuberculata*.
 12. The periwinkle, *Littorina littorea*.
 13. The soft whelk, *Buccinum undatum*.
 14. The hard whelk, *Fusus antiquus*.
- b. In other countries :—
- (In addition to the above)
1. *Venus mercenaria* (American "Clam").
 2. *Venus verrucosa* (French "La Praire").
 3. *Tapes decussata* (French "La Clovisse").
 4. *Tapes pullastra* (French "Palourde").
 5. *Donax vittatus* (French "Petite Clovisse").
 6. *Lithodomus lithophagus* (French "La Datte de Mer").
 7. Various species of Cephalopoda (French "Le Poulpe," "La Pieuvre," "La Seiche," &c.)
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H.—Collection illustrating Oyster and Mussel Culture in France, Holland and other Countries.

H. I. OYSTER CULTURE AT ARCACHON (south of France).

1. Pieces of tile used as Collectors of Spat, showing the thickness of the limy covering.
2. Two tiles covered with the limy layer ready for placing in the parcs as collectors.
3. Model of the "gabaret" or case of collecting tiles.
4. Two tiles covered with young spat.
5. Two tiles covered with young oysters 1 year old.
6. Series of specimens of young *Ostrea edulis* (common Oyster) 1 year old.
7. Series of specimens of young *Ostrea edulis* (common Oyster) 2 years old.
8. Series of specimens of *Ostrea edulis* (common Oyster) 3 years old.
9. Series of specimens of young *Ostrea angulata* (the Portuguese Oyster) 1 year old.
10. Series of specimens of young *Ostrea angulata* (the Portuguese Oyster) 2 years old.
11. Series of specimens of *Ostrea angulata* (the Portuguese Oyster) 3 years old.
12. Series of photographs of the oyster culture at Arcachon.

H. II. OYSTER CULTURE AT IERSEKE, ZEELAND, HOLLAND. (From Mr. Harmelen, Ierseke.)

1. Map of the Ooster Scheldt showing position of Oyster beds.
2. Photographs of the Oyster culture at Ierseke.
3. Two tiles with young oysters in first year.

4. Two tiles with young oysters in second year.
5. Two tiles after "detroquage" or separation of the young oyster from the tile.
6. Series of young oysters a few months old adhering to various shells.
7. Series of young oysters 1 year old.
8. Series of young oysters 2 years old.
9. Series of marketable Dutch oysters.
10. Series of very large old Dutch oysters.

H. III. OYSTER REARING AND FATTENING AT MARENNES, in west of France.

1. Series of green oysters from Marennes.
2. Photographs of the "Claires" at Marennes.
3. Specimens of the vegetation from the Claires (consisting of *Cladophora* and other Algæ covered with Diatoms, &c.).
4. Specimens of the deposit from the floor of the Claires.

H. IV. DISEASED CONDITIONS, AND EXPERIMENTS ON OYSTERS AND OTHER SHELL-FISH.

1. Oysters shells eaten into by the Sponge *Cliona celata*.
2. Oyster shells completely buried in the Sponge.
3. Oyster shells with mud between laminæ of shell.
4. Injured oyster shells.
5. American oyster from Fleetwood suffering from the green disease.
6. A normal healthy green Marennes oyster for comparison with the last.
7. Oysters which have been trephined in order to investigate the green disease.

8. Oysters kept in Copper solutions.
9. Oysters kept in Iron solutions.
10. Shell perforated by a boring Mollusc.
11. Weak and deformed shells.
12. Fresh water Mussels showing erosion of shell.
13. „ „ showing formation of pearls.

H. V. MUSSEL CULTURE ABROAD.

1. Illustrations of the Bouchot system at the Bay of Aiguillon on west coast of France.
2. Illustrations of the vertical system in Bay of Spezia, Italy.
3. Mud from Mussel bouchots at Charrons.
4. Model of Mussel bouchot.
5. Mussel adhering by its byssus.

H. VI. OUR MUSSEL BEDS.

1. Chart of district showing mussel beds.
2. Sample of mud from bed between Scarfhole and Duddon.
3. Sample of mud from bed north side of Scarfhole, near Barrow.
4. Sample of mud from bed south side of Scarfhole, near Barrow.
5. Sample of mud from Walney side, upper end of Scarfhole.
6. Sample of mud from Head Scar, Barrow Channel.
7. Sample of mud from Foulney bed, near Piel.
8. Sample of mud from Roosebeck outer Scars, near Piel.
9. Sample of mud from bed between Roosebeck and Baicliff.

10. Sample of mud from Baicliff Scars, near
Mort bank.
 11. Sample of mud from Morecambe beds.
 12. Sample of mud from Big Ford, River Wyre.
 13. ,, ,, Green Scar, ,,
 14. ,, ,, Knott, ,,
 15. ,, ,, Hamill Point, ,,
 16. ,, ,, Lighthouse Scar, St. Annes.
 17. ,, ,, Lower Beds, ,,
 18. ,, ,, Church Scar, ,,
 19. ,, ,, Wallasey Bed.
 20. ,, ,, Egremont Bed.
-

I.—Collection of Edible Crustacea.

Common crab (*Cancer pagurus*).

Lobster (*Homarus vulgaris*).

Sea Crayfish or Norway lobster (*Nephrops norvegicus*).

Spiny Lobster (*Palinurus vulgaris*).

Shrimp (*Crangon vulgaris*).

Shank (*Pandalus annulicornis*).

Prawn (*Palaemon serratus*).

K.—Collection of Sea-bottoms.

K. I. TYPICAL SUBMARINE DEPOSITS.

1. Terrigenous.
 - a.* Gravel.
 - b.* Sand.
 - c.* Mud.
2. Neritic.
 - a.* Nullipore.
 - b.* Shells.
 - c.* Shell sand.
 - d.* Coral sand.
3. Pelagic or Planktonic.
 - a.* Globigerina ooze.
 - b.* Radiolarian ooze.
 - c.* Diatom ooze.

K. II. SUBMARINE DEPOSITS OF THE IRISH SEA.

1. Terrigenous.
 - a.* Gravel from Bradda Head.
 - b.* Sand from Liverpool Bar.
 - c.* Mud from deep Channel.
 - d.* Sand from Bahama Bank.
 - e.* Sand from King William Bank.
 2. Neritic.
 - a.* Nullipore from off Dalby.
 - b.* Shell sand from off Spanish Head.
 - c.* Shell sand from off Calf of Man.
 3. Model of Floor of Irish Sea.
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L.—Collection of Natural Fishing Baits.

1. The Lug worm (*Arenicola piscatorum*), used for the small lines, especially for flat fish.
 2. The Rock worm (*Nereis versicolor*), used for the long lines.
 3. The soft whelk (*Buccinum undatum*), used for the long lines, especially for large Cod.
 4. The Crab (*Carcinus mænas*), used for the long lines for all kinds of fish.
 5. The Mussel (*Mytilus edulis*), used for the small lines for all kinds of fish.
 6. The Scallop (*Pecten opercularis*), used for the long lines, especially for Haddock and Cod.
 7. The Squid (*Loligo vulgaris*), used for the long lines, especially for Cod.
 8. The Sand-Eel (*Ammodytes tobianus*), used for small lines, especially good for Whiting.
 9. The Conger (*Conger vulgaris*), for all kinds of large fish.
 10. The Sea Anemone (*Actinoloba dianthus*).
 11. The Sprat (*Clupea spratta*), used for both long and small lines for all kinds of fish.
 12. The Cockle (*Cardium edule*), used chiefly for the small lines for all kinds of fish.
 13. The Horse Mussel (*Mytilus modiolus*), used chiefly for the small lines for all kinds of fish, good for Codlings.
 14. The Limpet (*Patella vulgata*), used chiefly for the small lines, good for Haddock.
 15. The Razor Fish (*Solen siliqua*), used for long and small lines for all kinds of fish.
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M.—Collections of Models of fishing implements, and of apparatus, &c., for fish culture and shell-fish cultivation.

1. Water wheel for keeping hatching tank in constant motion.
2. Model of Capt. Dannevig's Sea-fish Hatchery in Norway (on loan, from J. W. Woodall, Esq.)
3. Model of a Dutch Oyster farm.
4. „ a “ bouchot ” for mussel culture.
5. „ the Irish Sea, showing Lancashire Sea-Fisheries District, Spawning grounds, &c.
6. Model of Fish Trawl.
7. „ Otter Trawl.
8. „ Shrimp Trawl.
9. „ Shrimp shank net.
10. „ Shrimp shank net, with raised beam to prevent capture of small food fish (with Mr. Dawson's drawing and description).
11. Model of Shrimp push net.
12. Cockle “ Rake,” “ Craam,” and “ Jumbo.”
13. Mussel “ Rake.”
14. Portion of Deep Sea Cod line, Cod and other fish hooks, Cod line buoys.
15. Model of Dredge.
16. „ Tow-net.
17. Set of Sieves, Collecting bottles, tubes, &c.
18. Zoologists' Deck table, for microscope work (Prof. Herdman's pattern).

N.—Series of Photographs and Lantern slides, illustrating the methods of Fishing, the Fish, the Marine Fauna, &c., of the Lancashire Sea-Fisheries District.

O.—Collection illustrating the Regulations of Sea-Fisheries Committees and other Authorities.

1. Series of samples of nets on frames showing meshes of 4, $4\frac{1}{2}$, 5, 6, 7, 8 and 10 inches in circumference.
2. Series of gauges for measuring fish trawl nets, stake nets, shrimp nets, drift nets, sparling nets, lobsters and crabs, oysters, mussels and cockles.
3. Series of Models showing the sizes at which it is proposed the chief edible fishes should be marketable according to :—
 - a. Select Committee of House of Commons and Board of Trade Bill; Soles and Plaice 8 inches, Brill and Turbot 10 inches.
 - b. National Sea-Fisheries Protection Association; Brill and Turbot 12 inches, Soles and Plaice 10 inches.
 - c. Resolution of Liverpool Fish Salesmen; Brill and Turbot 14 inches, Plaice, Lemon Soles and Witch 10 inches, Soles 9 inches.
 - d. Biological basis (*i.e.*, sexual maturity); Soles 12 inches, Plaice 17 inches, Brill 15 inches, Turbot 18 inches, Lemon Soles 12 inches.
 - e. Present law in Belgium; Soles and Plaice 7·2 inches, Brill and Turbot 10 inches.
 - f. Present law in Denmark; Plaice 10 inches and Brill $13\frac{3}{4}$, Turbot 8 inches, Sole $11\frac{3}{4}$, Dab 7, and Witch 7.
 - g. Present law in France; Soles and Plaice $5\frac{1}{2}$ inches.

4. Models showing legal and illegal sizes of Crabs, &c.
 5. Series showing varies sizes of edible crab from 1 inch to 4 inches.
 6. Model of Lancashire Sea-Fisheries Steamer "John Fell."
 7. Model of Lancashire Sea-Fisheries Police Sailing cutters.
 8. Photographs of the Fishing steamers, Police boats, and Fishing boats.
 9. Copies of the Bye-laws of the Lancashire Sea-Fisheries District.
 10. Copies of the Superintendent's Quarterly Reports, of the Annual Reports of the Sea-Fisheries Laboratory, and other papers showing results of investigations and experiments in the District.
 11. Copies of Fishery Officers' Monthly Reports, Diaries, &c.
 12. Copies of L.M.B.C. Reports on "Fauna of Liverpool Bay."
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FURTHER REPORT upon the FREE-SWIMMING
COPEPODA of the WEST COAST
OF IRELAND.

By ISAAC C. THOMPSON, F.L.S.

[Read May 14th, 1897.]

THE former Report (Trans. Biol. Soc., L'pool, Vol. X., p. 92) dealt with a collection of plankton, the result of a series of tow-nettings made by my friend Mr. Edward T. Browne, B.A., of London, off Valencia on the West of Ireland during the summer and autumn of 1895.

Mr. Browne again made Valencia his head-quarters in July 1896, remaining there until near the end of September, using the tow-net on most suitable days either inside or outside of the harbour. The results are contained in 41 bottles, numbered 1 to 41 in accompanying tabular resumé, the total number of species found being 29. During part of the time Mr. Browne had as companions Mr. A. O. Walker, F.L.S., of Colwyn Bay, and Mr. F. W. Gamble, of Owens College, Manchester. Both of these gentlemen have kindly sent me material they collected by tow-net. The conditions under which the latter were obtained being similar to those of Mr. Browne, they are included in the tabulated results, having no specially distinctive features. Through the kindness of the Misses Delap, daughters of the Vicar of Valencia, themselves trained naturalists, the work of tow-netting was continued throughout the autumn and winter up to March 1897, the bottles numbered 22 to 41 being contributed by them.

The previous Report had to do chiefly with tow-nettings taken during the months—April, May and June 1895.

while those here referred to were collected from July 1896 to March 1897. We have thus a year's continuous series of material to report upon which should enable us to obtain a fair knowledge of the distribution of the free-swimming Copepoda of this district.

Mr. Browne informs me that the tide flows into Valencia Harbour from the ocean at a good pace. Two knots is the speed marked on the chart, being strong enough to keep the tow-net fully extended from a boat at anchor. The average depths to which the tow-net was lowered are given, but the results do not appear to show any great difference in the fauna at the bottom and at the top, possibly to be accounted for by the fact that the tide runs through a narrow entrance and the water is well stirred up.

All the material collected for examination was immediately preserved in Formaline. A 5% solution appears to be the strength best suited for these small delicate crustaceans, and is probably as efficient a preservative as is known.

NOTES ON THE SPECIES FOUND.

Calanus finmarchicus and *Clausia elongata* were found in all the bottles and were generally the prevailing forms. The much rarer *Calanus propinquus* occurred very sparingly during January and February. It differs from *C. finmarchicus* chiefly in the profusely plumose character of the setæ, and in the 5th swimming feet, and the diverging caudal segments of the male.

Pseudocalanus armatus was found but on one occasion (Feb. 27th) and then only one specimen.

Temora longicornis was generally abundant up to the end of October, but was not found during the mid-winter months, occurring again sparingly in February, and

becoming common in March. *Metridia armata* a species not usually common, occurs in more than half the bottles and on some occasions in fair numbers, especially during the winter months. The gradually tapering setose antennæ and the leaf-shaped terminations to the swimming feet, distinguish it readily. One of the rarest species taken, and previously unknown to the district is *Rhincalanus cornutus*, easily distinguished by its long projecting cruciform rostrum, and by its antennæ. On two occasions, in August and October, one specimen only was found. It has only I believe been previously reported in Britain on one occasion, by Mr. Thomas Scott, off the Shetland Isles.

Centropages hamatus occurs in half the bottles, but usually sparingly, and *C. typicus* much less frequently.

In a tube sent to me by Mr. A. O. Walker were two specimens belonging to the Dublin Museum collection, and marked "West of Ireland," which on examination proved to be *Euchæta marina* and *Pontella kroyeri* both new to the district and very uncommon in our northern seas, although I have previously taken one specimen of each in the L.M.B.C. district.

Isias clavipes occurs on only three occasions. *Acartia clausii* was generally found and fairly plentiful, except during spring and early summer, and *Oithona spinifrons* under much the same conditions. *Candace pectinata* a species generally rare in our seas, has proved to be here not uncommon, occurring, however, only during the summer and early autumn. On only two occasions throughout the year that very conspicuous species the beautifully coloured *Anomalocera patersonii* was found, while as alluded to in the last report it sometimes occurs in our seas in dense shoals.

It was interesting again to find the southern species

alluded to in the previous report, *Corycaeus speciosus*, though on only one occasion, and more frequently its very similar ally *C. anglicus*, the latter having been frequently reported from Plymouth.

Parapontella brevicornis occurred once in July and on several occasions in February. One specimen of *Monstrilla danæ* was taken on August 3rd. Great interest attaches to the family Monstrillidæ through the recent important discovery of Prof. Giard of Paris and confirmed by M. Malaquin that the early stages of one or more species of this group are spent parasitic in the body cavity of certain worms (see *Comptes rendus*, 16 novembre 1896, and 28 decembre 1896, and 11 janvier 1897).

Caligus rapax was collected in the tow-net on two occasions by the Misses Delap in December and January. The various species of the genus *Caligus*, though all fish parasites, are not uncommonly found as free-swimmers particularly at night.

The eight species, viz., *Harpacticus fulvus*, *Thalestris longimana*, *T. clausii*, *Ectinosoma spinipes*, *Longipedia coronata*, *Cyclopina littoralis*, *Porcellidium viride*, and *Laophonte hispida* are all fairly common littoral forms, generally found in rocky pools or near to shore. Their presence again suggests the regret that in addition to the valuable collection taken by tow-net, Mr. Browne and his co-workers did not preserve mud and sand dredged at various depths, and the washings of dredged material. For judging by results in Liverpool Bay it is to these sources we must chiefly look for forms new to science among the Copepoda. While we have doubtless still much to learn as to the causes which influence the distribution of the free-swimming forms, we can hardly now expect to add very many to the number of those

COPEPODA.

26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
October 16, 1896.	Harbour, 3 fathoms, October 17, 1896.	Harbour, 2 fathoms, October 23, 1896.	Harbour, 2 fathoms, Nov. 23, 1896.	Harbour, 1½ fathoms, Dec. 16, 1896.	Harbour, 1½ fathoms, January 4, 1897.	Harbour, January 10, 1897.	Harbour, 3 fathoms, January 15, 1897.	Harbour, 2 fathoms, January 27, 1897.	Harbour, 2 fathoms, January 29, 1897.	Harbour, 2 fathoms, February 2, 1897.	Harbour, 2 fathoms, February 4, 1897.	Harbour, 3 fathoms, February 15, 1897.	Harbour, February 27, 1897.	Harbour, 1 fathom, March 6, 1897.	Harbour, March 8, 1897.
A	A	F	F	A	A	F	F	F	F	F	F	F	C	A	A
C	C	A	A	A	A	A	A	S	S	A	S	A	A	A	A
A	A	A	F		F	C	C	C	C	C	F	F	S	C	C
		F			F					S		C	F		C
	C	F	A	A	A	A		C	F		C	C	S	S	S
	F		F				F	C	F	C	C	C	F	F	F
	S			S					S	S	S	S	F		F

A signifies Abundant.

C „ Common.

F „ Few.

S „ Scarce.

VALENCIA TOW-NETTINGS—TABLE SHOWING DISTRIBUTION OF COPEPODA.

DATE, LOCALITY, AND DEPTH (WHERE NOT STATED) = SURFACE.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
Valencia hbr., 6-7 f., July 20, 1896.	Valencia hbr., 5-7 f., July 22, 1896.	Inside ent. to hbr., 7-9 f., July 27, 1896.	Harbour entr., 6-8 f., July 31, 1896.	Harbour entrance, 7 f., August 1, 1896.	Outside hbr. ent., 10 f., August 3, 1896.	Near hbr. ent. (inside) 7 f., Aug. 4, 1896.	Near hbr. ent. (inside) 6 f., Aug. 7, 1896.	1 mile outside hbr. 5 f., August 10, 1896.	Harbour entr., 7-8 f., August 15, 1896.	Harbour entrance, 7 f., August 18, 1896.	Harbour entr., 2-4 f., August 19, 1896.	Harbour entrance, 3 f., August 22, 1896.	Harbour entr., 2-4 f., August 24, 1896.	Hbr. entrance (inside) August 29, 1896.	Hbr. entrance (inside) Sept. 1, 1896.	Hbr. entrance (outside) Sept. 2, 1896.	Harbour, 2-5 fathoms, Sept. 7, 1896.	Harbour entr. 1-3 f., Sept. 10, 1896.	Harbour, 1-4 fathoms, Sept. 18, 1896.	Harbour, 5-6 fathoms, Sept. 21, 1896.	Harbour, 2 fathoms, Sept. 30, 1896.	Harbour, 2 fathoms, October 2, 1896.	Harbour, 3 fathoms, October 13, 1896.	Harbour, 5 fathoms, October 14, 1896.	Harbour, 4 fathoms, October 15, 1896.	Harbour, 3 fathoms, October 17, 1896.	Harbour, 2 fathoms, October 23, 1896.	Harbour, 2 fathoms, Nov. 23, 1896.	Harbour, 1½ fathoms, Dec. 15, 1896.	Harbour, 1½ fathoms, January 4, 1897.	Harbour, January 10, 1897.	Harbour, 3 fathoms, January 15, 1897.	Harbour, 2 fathoms, January 27, 1897.	Harbour, 2 fathoms, January 29, 1897.	Harbour, 2 fathoms, February 2, 1897.	Harbour, 2 fathoms, February 4, 1897.	Harbour, 3 fathoms, February 15, 1897.	Harbour, February 27, 1897.	Harbour, 1 fathom, March 6, 1897.	Harbour, March 8, 1897.		
<i>Calanus finmarchicus</i>	A	C	A	A	A	A	A	A	A	C	C	C	C	F	F	F	F	C	C	F	C	F	C	C	F	A	A	F	F	A	A	F	F	F	F	F	F	C	A	A		
<i>C. propinquus</i>	A	A	A	A	F	A	A	A	A	A	C	C	A	A	A	C	C	A	C	F	C	C	A	C	F	A	C	C	A	A	A	A	F	F	F	F	F	F	C	A	A	
<i>Clausia elongata</i>	A	A	A	A	F	A	A	A	A	A	C	C	A	A	A	C	C	A	C	F	C	C	A	C	F	A	C	C	A	A	A	A	F	F	F	F	F	F	C	A	A	
<i>Pseudocalanus armatus</i> ..	A	A	C	C	A	A	A	A	A		C	C	C	C	C	C	C	C	C	A	A	A	C	F	A	A	A	A	A	A	A	A	A	C	C	A	A	A	A	A	A	
<i>Temora longicornis</i>		C	F	A		C	F	F	C		S	F	C	F	C	C	C	C	C	F	A	S	C	F	A	A	A	A	F		F	C	C	C	C	C	F	C	A	C	C	
<i>Metridia armata</i>																																										
<i>Rhincalanus cornuta</i>		F			F		F	F		F	S	F	C	F	C	F	C	F	F		S	C	C												S							
<i>Centropages hamatus</i>																																										
<i>C. typicus</i>																																										
* <i>Euchaeta marina</i>																																										
<i>Isias clavipes</i>																																										
<i>Acartia longiremis</i>					F	F				F	F	C	F	F	A	F	C	F	F	F	A	A	C	F	A	A	A	C	F	A	A	A	A		C	F		C	C	S	S	S
<i>Candace pectinata</i>				F	C	F			F	F	C	S	F	F	F	C	C	C	F		A	A	F	C	F	A	A	C	F	A	A	A	A		C	F		C	C	S	S	S
<i>Anomalocera patersonii</i> ..																																										
* <i>Pontella kroyeri</i>																																										
<i>Oithona spinifrons</i>						F		F	F		F	F	F			F		F	F		C	C	C	C	C	C	C	C	F	F					C	C	C	S	F	F		
<i>Parapontella brevicornis</i> .				S																																						
<i>Harpacticus fulvus</i>																																										
<i>Thalestris longimana</i>																																										
<i>T. clausii</i>																																										
<i>Ectinosoma spinipes</i>																																										
<i>Longipedia coronata</i>																																										
<i>Cyclopina littoralis</i>																																										
<i>Corycaeus speciosus</i>																																										
<i>C. anglicus</i>																																										
<i>Porcellidium viride</i>																																										
<i>Laophonte hispida</i>																																										
<i>Monstrilla danae</i>						S																																				

*Date and locality not recorded.

A signifies Abundant.
C " Common.
F " Few.
S " Scarce.

already known. But with the vastly more numerous, mud loving, sedentary, and wholly or semi-parasitic species of Copepoda the case is different. Investigations as to the food of fishes have shown us that even scarce species, and but recently known Copepoda, as in the case of *Jonesiella hyænæ*, are found largely in the stomachs of young fishes, being evidently selected as their chief food and probably found in quantities near to the spawning grounds. From this aspect even apparently lifeless mud has under the microscope much to teach us. In addition to the examination of deposits it is evident that Sponges, Coelenterates, Echinoderms, Worms, Molluscs, Nudibranchs, and Ascidians will all richly reward careful search; for judging from past results, they are the hosts of many highly organized species of Copepoda, each specially adapted to its particular host and that alone.

While sincerely thanking Mr. Browne and his friends for the amount of valuable material collected, I must again express the hope that we may at a future time be enabled to know as much of the Valencia sedentary species of Copepoda as we now do of the free-swimmers.

The accompanying table represents the distribution of free-swimming Copepoda in or about Valencia harbour from July, 1896 to March, 1897.

A CONTRIBUTION to the HISTORY of the
 "CALDERSTONES," near LIVERPOOL.

Put together by Professor W. A. HERDMAN, D.Sc., F.R.S.

(December, 1896.)

"I lay me down upon the thymy turf
 Beside these mouldering stones, the silent tomb
 Of ancient hunter, or the tumulus
 Of warrior old ; quiet and undisturb'd
 Beneath the waving fern their reliques lie,
 And on their shelter'd bones, in frequent whirls
 Thick fall the autumnal leaves !"

*From poem suggested by scenery in the
 neighbourhood of Allerton and Woolton
 Hill ; by WILLIAM STANLEY ROSCOE,
 1834.*

INTRODUCTORY.

THE "Calderstones" are, as they at present stand, a set of six red sandstone (triassic) slabs, which form a small circle on a triangular plot of grass at the junction of Druids Cross Road and Beech Lane with the Calderstones Road about four miles south-east from Liverpool Exchange, on the way to Woolton. The stones are rough in surface, irregular in shape, and vary in size from about three feet by two feet to about six feet by five feet in length and height, they are all from one foot to eighteen inches in thickness.

The circle is enclosed by a low wall and a stout iron railing, and we learn from an inscription on the wall that the Calderstones were "enclosed and planted" by Mr. J. N. Walker in 1845. The word "planted" in this

inscription is generally supposed to refer to the grass and a fir tree in the centre of the circle; but Mr. Henry Walker, son of Mr. J. N. Walker, states that his father certainly "planted" at least some of the stones in their present positions.

Sir James Picton refers briefly to the stones as a circle of the Stone Age in his "Memorials of Liverpool" (vol. i., p. 2); Mr. A. L. Lewis describes briefly the orientation, "the highest stone being as at Stonehenge to the south-west," and says "I consider this circle to have been sacrificial" (*Journ. Anthropol. Instit.*, vol. i., p. 299, 1872); but the best descriptions are those given by Professor Sir James Y. Simpson in 1865 and by Mr. J. Romilly Allen in 1883.

At the time when Sir James Simpson examined them (see *Trans. Hist. Soc. Lanc. and Chesh.*, n. ser., vol. v., p. 257; 1865) only five of the stones were standing; now all of them are erect. Simpson gives figures of three of the stones, some measurements, and a detailed description of some of the older incised markings, which he supposes to have been made with flint tools. He describes the monument as "a small megalithic circle," and regards it as Pre-Celtic.

Romilly Allen (*Jour. Brit. Archæol. Assoc.*, vol. xxxix., p. 304; 1883) adds a little to Simpson's description, he gives a plan of the circle with further measurements, better figures of the more interesting sides of the stones, and he discusses more fully the nature and origin of the markings—especially the footprints. He traces the practice of carving footprints on stones from "the remote past of the Bronze Age" to the present day. Five of the stones bear a number of inscribed markings, some of which (spirals, circles, concentric rings and cups mostly) are pre-historic, others (footprints and crosses) Romilly

Allen believes to be mediæval, while some (footprints and initials) are modern (see cut fig. 1, p. 15).

Both these eminent Archæologists (and also Mr. Lewis, as stated above) describe the monument as a *circle*, and there seems no reason to doubt that they regarded the stones as being *in their original position*; and yet, as the following series of letters will show, there is a good deal of evidence, amounting to several independent accounts, that early in the present century the stones were not in their present position, but lay "scattered about," and that up to the end of last century, if not later, they formed part of a dolmen in or on a tumulus of sand placed some quarter of a mile to the south-west of the present site. The several accounts given in the letters are the recollections of well-known Liverpool gentlemen as to what they were told by members of a former generation who were eye-witnesses of the scattered condition of the stones, of the tumulus of sand, of the more or less ruined dolmen, and of the cinerary urns which were disclosed on removing the sand for building purposes. So far as I can discover there is no one now living in the neighbourhood who remembers the stones in their former condition and position, although some few years ago there can be no doubt (from the evidence in the letters) such testimony could have been obtained.

It is important to notice (see Mr. Ryley's letter) that an old map of Liverpool (Enfield's, 1768) confirms the account given by Mr. Cox, Dr. Newton and others as to the position of the tumulus.

As a number of members of the Liverpool Biological Society (before which Society this evidence of a former dolmen and tumulus was first produced) have expressed the opinion that a permanent record should be made of the information now collected, the Council of the Society

requested me to draw up this account of my remarks before the Society on November 13th, 1896, as to the probable nature of the Calderstones, and of the correspondence they gave rise to, for publication in the "Transactions" as a contribution to local history.

W. A. H.

REPORT OF THE MEETING.

At the second meeting of the Biological Society for the present session, held on November 13th, I gave an address on "The Menhirs and Dolmens of Brittany and other Pre-historic Remains," at the conclusion of which, after describing the Calderstones and their markings, I suggested that these standing stones had originally formed part of a dolmen. This led to a considerable discussion and at the end I was requested to write a letter to one of the Liverpool daily papers stating the facts and asking those who had any information to put it on record.

I consequently wrote the following letter, which appeared in the Liverpool "Daily Post" for Nov. 17th.

"WHAT ARE THE CALDERSTONES?"

To the Editor of the Daily Post.

"SIR,—A somewhat dramatic incident occurred last night at the meeting of the Biological Society, in connection with the original position of the Calderstones; and at the conclusion of the meeting the opinion was expressed by a number of those present that you should be asked to record in your columns any facts that can still be elicited as to the condition of this local megalithic monument in the early part of the present century. In the paper read last night to the society on the Dolmens of Brittany, I concluded by comparing the spiral and other markings on the Calderstones with the carvings on various neolithic dolmens, and I suggested that the Calderstones were originally part of a small dolmen, which had gone to ruin, and had then been re-erected in their present position by some one who supposed that all so-called 'Druidical stones' should stand in a circle. This was no sooner said than Mr. E. W. Cox, who was present as a visitor, and of whose

presence and opinions I had no knowledge, rose up and said, 'You are quite right. The Calderstones were originally a dolmen on the top of a tumulus at some distance from where they now stand.' He went on to give interesting particulars, derived from an old gardener, as to the condition of the tumulus and the stones before the present roads in that neighbourhood were made. Mr. Cox was followed by Dr. Newton, who had also heard from a former generation of the original position of the Calderstones in a tumulus, and of the remains found in the tumulus when it was cleared away. I believe that Mr. James Thornely can also give some evidence bearing on this opinion—at which I had arrived entirely from an examination of the carvings and a comparison with similar incised stones elsewhere—that the Calderstones, now standing in a small circle, were originally part of a dolmen.

"I write this letter at the request of several members of the Biological Society, for the purpose of suggesting that Mr. Cox and others who have clear evidence to give bearing upon the question should be invited to put what they know as to the earlier condition of the Calderstones upon record. The writings of Sir James Simpson, Mr. Romilly Allen, and Sir James Picton, describe the stones in their present position, except that one of the six stones has evidently been erected between the dates of Sir James Simpson's (1865) and Mr. Romilly Allen's (1883) papers."—Yours, &c.,

W. A. HERDMAN.

As a result of that enquiry the following letters, amongst others, appeared in the "Daily Post" of November 21st.

To the Editor of the Daily Post.

"SIR,—It is pleasant to find from the letter of Professor W. A. Herdman that some interest is at last being taken in the investigation of our neglected local antiquities, which are more interesting and greater in number than is commonly supposed, and I gladly respond to the wish expressed by him to give the evidence I have collected relating to them, and of which a short note by myself has already been contributed to the 'Proceedings of the Historic Society of Lancashire and Cheshire.' The best plan is, I think, to give as nearly as possible the exact words of my informant, followed by my own conclusions based upon them. By this means other archaeologists can estimate whether or not they are correct.

"About twenty years ago, my gardener, John Peers, who was a member of an old local family, a most trustworthy, honest, and intelligent man, who died a few years ago at over ninety years of age, informed me, in reply to questions I asked him as to local antiquities, customs, and condition of the neighbourhood, that he had begun his work on Calderstones Farm as a boy of about fourteen years of age. He remembered the Calderstones well, before

they were set up in their present position. The roads at that time were narrow country lanes. At this place there are four cross roads, and the stones lay upon a large mound at the roadside, high above the road, on (as far as I could make out the position) the south side. Only a few of the larger stones could be seen lying flat near the top, partly buried in the earth, and a few of the points of the other stones. Upon this mound, in the summer, after work, and on Sundays the boys and men from the neighbouring farms would come and lie in the sun. It was the fashion for the boys to cut their names and initials on the stones, and the patterns of their boots. He had marked his own foot upon the stone. (In after life it was a large one, he being a tall, powerful man.) He thought the naked feet marked on the stones were done then; he was not quite sure. Such marks are still visible on the stones. He well remembered the mound being destroyed. They were widening the road about the time it was done away with. When they dug down into it they found more of the stones, and the marked ones were among them.

“For some time the stones were laid aside on the farm, and afterwards some of the gentlemen of the neighbourhood had those now standing set up; others were taken away. Mr. Booker had the largest and set it up in his field, where it now is for the cattle to rub on. He thought there were two more large stones, but did not remember what became of them. When the stones were dug down to, they seemed rather tumbled about in the mound. They looked as if they had been a little hut or cellar. Below the stones was found a large quantity of burnt bones, white and in small pieces. He thought there must have been a cartload or two. He helped to wheel them out and spread them on the field. He saw no metal of any sort nor any flint implements, nor any pottery, either whole or broken; nor did he hear of any. He was quite sure the bones were in large quantity, but he saw no urn with them. Possibly the quantity was enhanced by mixture with the soil. No one made much of old things of that sort in his time, nor cared to keep them up. Dr. Newton has obtained some records of the finding of an urn; also that the mound was of sand, which is a fact of interest as bearing on certain other antiquities. The soil is clay.

“This simple but very significant narrative gives us, in untechnical language, a true and fully recognisable detail of the original character of the Calderstones as a chambered tumulus, or a dolmen covered by a sepulchral mound. These monuments were formed of large stones set up edgewise to form the walls of a chamber, and covered in with large slabs; they were sometimes made open upon the surface of the ground, at other times covered by a tumulus. The stones were, in late examples, ornamented on their inner surfaces with circles, curves, cupped hollows, and lines in great variety. Fergusson has brought some evidence to show that this class of monuments

was in use as late as the second or third century A.D., that at New Grange, in Ireland, being a magnificent example, with many divisions of its chambers. Other interesting discoveries of remains of urn burial at Wavertree are recorded in the Historic Society's transactions. One of the urns is in the Mayer Museum; also the few flint implements which were the only tools found with them. With such tools the carvings of the Calderstones and like monuments are supposed to have been made.

"The manner in which Professor Herdman identified the Calderstones as belonging to a dolmen or sepulchral chamber, having been unable to obtain any tradition of their original state shows his mastery of his subject, and it is to be hoped that he will continue his investigations with our other antiquities that have been hitherto neglected, or, still worse, misnamed and misread by superficial amateur antiquaries."—Yours, &c.,

Rock Ferry.

EDWARD W. COX.

To the Editor of the Daily Post.

"SIR,—In answer to Professor Herdman's inquiry as to these, I may say that in 'Enfield's History of Liverpool,' published in 1774, there is a map of the neighbourhood of Liverpool, drawn from a survey made in 1768. In this map, the Calderstones are clearly marked as being in a field, close to a hedge, a short distance to the south of their present site. The cross-roads where they now stand are shown on the map, but the stones are not marked as being there."—Yours, &c.,

19, Sweeting Street, Nov. 19th, 1896.

THOMAS C. RYLEY.

To the Editor of the Daily Post.

"SIR,—In your paper of the 17th inst. Professor Herdman suggests that the Calderstones are the remains of a small dolmen. But the dolmens are usually three upright stones, supporting a large table stone, whence the name. There are six Calderstones, which seem to have been each 6 feet high, and there is no trace of a great table stone. May they not rather be the remains of a cromlech, or stone sepulchral cell. The late Mr. Studley Martin knew an old lady, the daughter of a farmer, who lived as a girl near these Calderstones at the beginning of the century. And she remembered when the stones were still covered by a mound of earth or tumulus. Then a great house was built, and the contractor or builder, wanting sand, destroyed the tumulus, in which was found a fine sepulchral urn rudely ornamented outside. This, she said, was taken to a farmhouse in the neighbourhood, and has disappeared. Such was her story; it seems very probable. I have been much disappointed, after hunting through thirty-seven volumes of the Lancashire and Cheshire Society's "Transactions," to find only one paper on the Calderstones, that by the late Sir J. Y. Simpson, in the 17th volume.

This relates only to the cup and ring markings on some of the stones, which Simpson recognised as identical with many that he had figured from the early stone monuments of Scotland. An ancient British cemetery was unearthed at Wavertree in 1867, within a mile and a half of the Calderstones, in which eight fine sepulchral urns were discovered. The bones they contained had suffered cremation, and were associated with flint implements, but no metals. The find was well described by the late Mr. H. Ecroyd Smith in the Lancashire and Cheshire Historical Society's 'Transactions' for 1868. Let us trust that Professor Herdman will not rest until he has given us an exhaustive account of all that is known about the only monument of pre-historic man which remains in the neighbourhood of Liverpool."—Yours, &c.,

44, Rodney Street.

JOHN NEWTON.

To the Editor of the Daily Post.

"SIR,—In response to Dr. Herdman's appeal in the *Daily Post* for any information about the condition and position of the Calderstones at the beginning of this century, I beg to send you the little I have been able to acquire. From time to time I have spoken to many old inhabitants of the locality about these stones, and although their knowledge of them appeared very scanty, they all agreed in saying there was a kind of mound about the stones before their enclosure. This mound, they gave me to understand, was on the spot or very near the spot on which the stones now stand. The most definite and reliable testimony I heard came to me secondhand through two sources—from William Spencer, who kept a farm during the earlier part of this century at what is now the police station in Allerton, 200 or 300 yards away from the Calderstones. In 1845, whilst the workmen were engaged by Mr. Joseph Need Walker in building the lodge opposite, and enclosing the stones, this old man used to pass daily with his cows, and stop to talk with the men. One of these workmen told me that he remembered quite well how Spencer once said, pointing to the place, he had taken many a cartload of soil away years ago. The workman said there were no remains of the mound there then, and the stones lay scattered about here and there in front of the lodge. They were collected by the men, who placed them in a circle so as to be just opposite the entrance to Calderstones House. A nephew of the same Spencer also informed me that his uncle used to say that there was a very high and extensive mound on which the stones formerly stood, and that he had removed the soil for the purpose of making mortar in the building of the 'Bragg's' houses on the Woolton-road. These houses were built by an eccentric Liverpool clergyman of the name of Bragg, before the year 1805. Spencer, it was reported, found an 'urn' amongst the *debris*, which he gave to Mr. Nicholas Ashton, of Woolton Hall. And an old lady

once informed me that when she was a young girl, say, about 1820, she heard that human remains had been found in the mound."—Yours, &c.,

Nov. 19th, 1896.

R. E. ROBERTS.

A few days afterwards Mr. Cox added the following to the information given in his former letter. This appeared on November 23rd.

To the Editor of the Daily Post.

"SIR,—In 'Lewis's Topographical Dictionary,' my copy of which was published in 1849, is the following account of these antiquities:—'Here (at Allerton) is a large monument called Calderstones, in digging about which, more than sixty-years ago, urns of coarse clay were found, containing human bones. They were surrounded by a neat iron palisade in 1845.' This account shows that about 1789 this mound was disturbed, and it remarkably bears out the account given by the late John Peers, who saw it at its subsequent destruction. The urns, and possibly other relics, when this took place, had been previously removed, and the contents evidently thrown out into the soil. Doubtless the dolmen, or sepulchral chamber, was about 1789 ruined, as about 1814 the stones were found 'tumbled about.' The quantity of bones spoken of were also the contents of a number of urns. This additional information points to the conclusion that the tumulus with its chamber was a tribal burying-place, probably of the late Celtic age, either of the bronze or late neolithic period. It also indicates, if this statement is exactly worded, that the urn burials were most likely secondary interments, as they were found in 'digging about' the stones, not within the Cist-vaen. In this vicinity, therefore, we should expect to find traces of a primitive settlement, and, as a matter of fact, a camp is marked on Woolton Hill in early copies of the Ordinance Survey, at a point overlooking the Calderstones."—Yours, &c.,

EDWARD W. COX.

Other letters appeared during the following week, from Mr. James Thornely, Mr. J. F. Mansergh, Mr. W. Spensley, Mr. William Bristow, and Mr. J. Thompson, which, however, added little to the evidence given above. Mr. Thornely remarks in the course of his letter:—

. . . "I remember, however, being told by the late Mr. Ambrose Lace that the stones were originally under a heap of sand, and that Mr. Roscoe, then residing at

Allerton Hall, who often passed that way, caused them to be displayed."

Mr. Mansergh, in his letter, gives a quotation from the first edition of Baines' "History (&c.) of the County Palatine of Lancaster," 1824-25, in which the Calderstones are mentioned as Druidical remains, and the fact is noted that . . . "in digging about them, urns, made of the coarsest clay, containing human dust and bones, have been discovered." . . . The quotation ends with:—"Some of these urns were dug up about sixty years ago, and were in the possession of Mr. Mercer of Allerton" (vol. ii., p. 698).

Some of the gentlemen mentioned above, and a number of others, also wrote to me privately giving supplementary information. Mr. T. C. Ryley adds to his published letter that according to the scale on Enfield's map the circle which marks the position of the Calderstones in 1768 is "as nearly as possible quarter of a mile to the south-west of the cross-roads where the stones are now set up."

Mr. P. Cowell writes (Nov. 23rd) "I notice in Bennison's map of Liverpool and neighbourhood, 1835, that the Calderstones appear to be in a field quite removed from any road or lane, but not near the Bragg's houses."

I have myself seen this map and also Perry's, Enfield's and others of dates between 1768 and 1835, both in the libraries here and at the British Museum.* None show the Calderstones in their present position at the cross-roads.

* I am indebted to Mr. T. N. Morton for kindly allowing me to examine the old maps and records under his charge at the Municipal Offices; to Dr. Garnett, Mr. Fortescue, and others for help at the British Museum; and to Mr. Peter Cowell at the Liverpool Free Library, Mr. Sampson at University College Library, and Mr. Shaw at the Athenæum Library for similar help in Liverpool,

Mr. Alfred O. Walker (Colwyn Bay) writes to me that his cousin, Mr. Henry Walker, eldest son of Mr. J. N. Walker, says that his father "changed the position of *some* of the stones," and he has no doubt that he "brought them together into the enclosure."

Mr. Robert Gladstone writes (Nov. 25th) as follows:—

"As regards what I know *myself* it is not much, but I remember the stones before Mr. Walker of Calderstone enclosed them with the present railings in 1845. There were three or four of the stones standing upright, and others were lying about, one or two at some distance off. The late Mr. Studley Martin—whose family lived at Calderstone before Mr. Walker bought the place—told me several cinerary urns had been found among the stones, and these urns were put into a loft at a farmhouse belonging to a Mr. Mercer, where Beechley was afterwards built (where Mr. Blessig now lives), and he (Studley Martin), with other boys, used to play with the urns in the loft, rolling them about and against each other, and throwing stones at them till at last they were all broken to pieces and disappeared. The Calderstones were originally in a tumulus of sand, and the sand was taken away to mix with mortar for building the house called 'Woolton Lodge'—which stood on the site of the present Druid's Cross house (where Sir J. T. Brunner lives). I think the probabilities are all in favour of the Calderstones having been a dolmen, or burying-place, and the position of those that were left standing suggested to Mr. Walker that there had originally been a circle, and he therefore set up the others in a way to complete a rough circle.

"There is an old man, about 80, in Woolton Village, who says he remembers when the big stones were twice as many as they are now and were lying all about the

place. I conclude that there was a dolmen inside a tumulus of sand and that when the sand was taken away, the stones were thrown about anyhow and the cinerary urns were removed to the loft aforesaid. . . .

“I have an oil painting, or sketch, of the Calderstones—which belonged to Mr. Studley Martin, which I bought at a sale of his furniture after his death. The painting shows the Calderstones as they were before they were railed in, but I don’t know the date.

“I shall have much pleasure in letting you have this picture to photograph. I had it cleaned and varnished—and its details are quite plain.”

Mr. Gladstone kindly sent me the picture (see fig. 2). It is impossible from it to make out the exact locality, or the point of view; but the present roads are not represented and the stones are certainly not as they at present stand. They are closer together and in such a position that they might well have formed part of a ruined Dolmen.

Sir John Brunner, of Druid’s Cross, Mr. Charles MacIver, of Calderstone House, and Mr. H. H. Hornby also kindly took more or less trouble in answer to my enquiry, but were unable to give or get from others in their neighbourhood any additional information.

Finally, after waiting a few days without receiving any further letters, I drew up the following summary of the evidence obtained and of the conclusions I had arrived at as to the probable history of the Calderstones:—

To the Editor of the Daily Post. ❧

“SIR,—I desire to thank your correspondents, and also others who have written to me privately, for the information they have contributed in answer to the questions I raised—namely, first, are the Calderstones in their original position, and condition; and, second, may they not be the remains of a dolmen or neolithic burial-place? The evidence that has come out has shown pretty clearly that the first question is to be answered in the negative, and the second in the affirmative. Mr. T. C. Ryley refers us to the map, dated 1768, in ‘Enfield’s History of Liverpool,’ which shows the Calder-

stones in a field, close to a hedge, a little way south of their present position; and Mr. Peter Cowell tells me that in Bennison's map (1835) they are still marked as in a field, and not on the road. It must be remembered, however, that a map is frequently of earlier date than the book in which it is published. The recollections of John Peers, as given by Mr. E. W. Cox,* also agree with the above in placing the stones to the south of the road in the early part of this century.

"We have now four independent accounts which agree in stating that the Calderstones were formerly in or on a tumulus or mound of sand, and that when the tumulus was removed one or more urns and a quantity of human bones were found. The four accounts are—(1) that of John Peers told to Mr. E. W. Cox, (2) that of William Spencer and also of his nephew, given by Mr. R. E. Roberts, (3) that of Mr. Ambrose Lace quoted by Mr. James Thornely, and (4) that of Mr. Studley Martin told both by Dr. Newton and also, with further details, in a letter which Mr. Robert Gladstone has sent me. In each case the eye-witness told the story to those now living.

"Mr. Gladstone tells me that there is an old man, of about eighty, in Woolton Village, who says he remembers when the big stones were twice as many as they are now, and were lying all about the place. The large number of the stones, I may remark, is no argument against the dolmen theory. Dr. Newton asks—does a dolmen not usually consist of only three upright stones supporting a large cover stone? Not necessarily. Most of the French dolmens have more than three upright stones, and some of those in Brittany have twenty or thirty; but it is true that the large table or cover stone usually rests upon only three of the uprights, doubtless because it is easier to place a table top steady upon three than upon any other number of supports.

"The tumulus, the urns, and the human bones (and therefore the dolmen or *cist-vaen* interpretation) seem certain. If we try to reconstruct the history further from the somewhat scanty evidence now collected (see especially Mr. Cox's two letters), it has probably been as follows:—

"1st, a neolithic (pre-Celtic) dolmen, the burial place of a chief or a family, inside a tumulus of sand; the spiral and cup and ring markings probably belong to this period, and possibly one or more of the urns (if obtained from the *interior* of the dolmen).

"2nd, some secondary interments in the tumulus around the dolmen, indicated by the urns dug out about 1789, and which, if we may judge from the Wavertree urns, which I have examined, probably belonged to the bronze (Celtic) period. They are of the type usually labelled 'British pottery' in museums.

* Mr. Cox has published a brief note on John Peers' story in *Trans. Hist. Soc. Lanc. and Chesh.*, n. ser., vol. xi., p. 246, 1896.

"3rd, about 1789 the mound was disturbed, and possibly, as a result, the dolmen was partly exposed and fell to ruins. About this period some of the later markings, including the footprints, were probably added when the top stones lay level with the top of the mound (see John Peers' story).

"4th, about 1805, the rest of the tumulus was carted away, and the stones were scattered. Probably some of the stones were destroyed and others removed (*e.g.*, Mr. Booker's) between this period and 1845, when Mr. J. N. Walker, of Calderstones, had some of them collected, placed in a circle, before his lodge, as at present, and enclosed by a railing.

"Several of your correspondents use the term 'Celtic' in connection with the Calderstones. The best authorities agree that the dolmen builders of North-Western Europe were of the neolithic age, and a pre-Celtic race."—Yours, &c.,

W. A. HERDMAN.

Nov. 28th, 1896.

It is possible that this account of what I have been able to gather together as to the former condition of the Calderstones may fall into the hands of someone who can give further information, or who has access to ancient maps, estate plans, or records in which the Calderstones are mentioned. I need scarcely say that I shall be much interested if the possessors of such information will kindly communicate with me.

There is in the Athenæum Library, Liverpool, a MS. map said to be copied from an original belonging to Richard Lathame, Esq., Lord of Allerton, previous to 1644, showing the lands in dispute between the Queen (? Elizabeth) and Richard Lathame.

This map shows between Allerton and Childwall a group of "Called-way-stones" and "Roger-stones," but is not sufficiently detailed and accurate to be of any real value. The original, however, if still in existence, and other old plans like it, showing this district on a large scale, may be of great antiquarian interest; and it is hoped that if any such exist in private hands the owners will take steps to make their contents known.

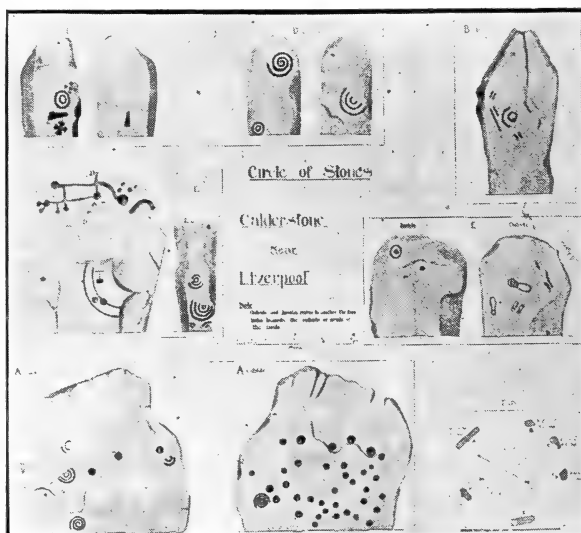


Fig. 1. The markings on the Calderstones, as shown in Mr. Romilly Allen's plates.

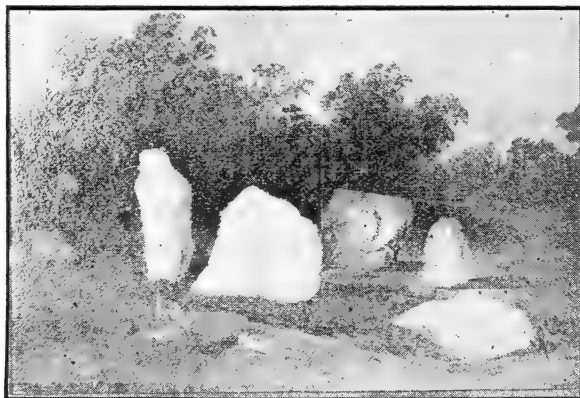


Fig. 2. The Calderstones, sometime previous to 1845, from an painting belonging to Robert Gladstone, Esq.

[WORK FROM THE PORT ERIN BIOLOGICAL STATION.]

REVISED LIST OF HYDROMEDUSÆ of the
L.M.B.C. DISTRICT.

By EDWARD T. BROWNE, B.A., F.Z.S.

[Read 12th January, 1897.]

SINCE the publication of my Report on the Medusæ of the L.M.B.C. District, in 1895, fresh researches in some cases have led to changes in the generic and specific names, and in other cases show that medusæ formerly regarded as distinct species are only early stages of other known species. I have given an account of these changes in nomenclature in a paper published in the Proceedings of the Zoological Society for 1896, upon which this Revision is based.

I append in tabular form a list of the Medusæ which I obtained at Port Erin in April, 1896, and notes on a few of the species.

HYDROMEDUSÆ.

I. ANTHOMEDUSÆ.

Codonium pulchellum (Forbes).

Fauna,* IV., p. 374.

Corymorpha nutans, Sars.

P.Z.S., 1896, p. 463.

= *Steenstrupia rubra*, Forbes.

Fauna, IV., p. 375.

Cytaeandra areolata (sp. ?) (Alder).

Fauna, IV., p. 390.

Dipurena halterata (Forbes).

Fauna, IV., p. 375; P.Z.S., 1896, p. 473.

Euphysa aurata, Forbes.

Fauna, IV., p. 376; P.Z.S., 1896, p. 474.

Hybocodon prolifer, Agassiz.

* Fauna of Liverpool Bay, 1895, Vol. IV., pp. 371—414. Reprinted from Trans. Liverpool Biol. Soc., Vol. IX., pp. 243—286.

P.Z.S., 1896, p. 466.

= *Amphicodon fritillaria* (Steenstrup).

Fauna, IV., p. 379.

Lizzia blondina, Forbes.

P.Z.S., 1896, p. 475; Fauna, IV., p. 393.

= *Dysmorphosa minima*, Hæckel.

Fauna, IV., p. 388.

Margelis principis, Steenstrup.

Fauna, IV., p. 394.

Margelis ramosa, Hæckel.

= *Margelis britannica* (Forbes).

Fauna, IV., p. 395.

Margellium octopunctatum (Sars).

Fauna, IV., p. 398; P.Z.S., 1896, p. 477.

Podocoryne carnea, Sars.

P.Z.S., 1896, p. 463.

= *Dysmorphosa carnea* (Sars).

Fauna, IV., p. 388.

Sarsia tubulosa, Sars.

Fauna, IV., p. 375.

Tiara pileata (Forskal).

Fauna, IV., p. 386.

Turris neglecta, Lesson.

Fauna, IV., p. 388.

II. LEPTOMEDUSÆ.

Eutima insignis (Keferstein).

Fauna, IV., p. 410; P.Z.S., 1896, p. 492.

Laodice calcarata, Agassiz.

Fauna, IV., p. 404.

Melicertidium octocostatum (Sars).

Fauna, IV., p. 405.

Mitrocomella polydiadema (Romanes).

Fauna, IV., p. 407.

Obelia lucifera, Forbes.

Fauna, IV., p. 406.

Phialidium cymbaloideum (Van Beneden).

P.Z.S., 1896, p. 491.

Phialidium temporarium, Browne.

P.Z.S., 1896, p. 489.

= *Phialidium variabile*, Hæckel.

Fauna, IV., p. 409.

Saphenia mirabilis (Wright).

Fauna, IV., p. 410 ; P.Z.S., 1896, p. 493.

Tiaropsis multicirrata (Sars).

Fauna, IV., p. 406.

NOTES ON THE MEDUSÆ taken in April, 1896.

Margelis ramosa. A young stage with 3 to 4 tentacles in each of the four groups. The oral tentacles twice dichotomously divided.

Margellium octopunctatum. All young stages with medusa-buds upon the manubrium.

Phialidium cymbaloideum. Young stages usually having four perradial tentacles ; a few, however, showed the commencement of the four interr radial tentacles.

Umbrella about 2 to 3 mm. in length and width, which is about twice the size of specimens belonging to a similar stage taken in Valencia Harbour, Kerry. The sudden increase in the number of specimens of the two species of *Phialidium* on 16th of April I am unable to account for.

Phialidium temporarium. All young stages, mostly with four tentacles. Umbrella about 1 mm. in diameter.

Podocoryne carnea. A young stage not long liberated from its hydroid. It is possible that the medusæ which I have described as *Cytæandra areolata* (Fauna, IV., p. 390) may be the later stages of a medusa budded off from one of the species of the hydroid *Podocoryne*.

Tiaropsis multicirrata. All the specimens belonged to young stages. Umbrella about 1 to 3 mm. in diameter.

LIST OF MEDUSÆ TAKEN AT PORT ERIN DURING APRIL, 1896.

APRIL	3	6	8	13	14	16	18	20	21	22	29
<i>Phialidium temporarium</i> , Browne	-	-	-	-	-	-	-	-	-	-	-
<i>Obelia</i> , sp.?	-	-	-	-	-	-	-	-	-	-	-
<i>Tiaropsis multicirrata</i> (Sars)	-	-	-	-	-	-	-	-	-	-	-
<i>Margelis ramosa</i> , Hækel	-	-	-	-	-	-	-	-	-	-	-
<i>Margellium octopunctatum</i> (Sars)	-	-	-	-	-	-	-	-	-	-	-
<i>Phialidium cymbaloideum</i> (Van Beneden)	-	-	-	-	-	-	-	-	-	-	-
<i>Aurelia aurita</i> (Ephyra-stage)	-	-	-	-	-	-	-	-	-	-	-
<i>Sarsia</i> , sp.?	-	-	-	-	-	-	-	-	-	-	-
<i>Podocoryne carnea</i> , Sars	-	-	-	-	-	-	-	-	-	-	-
<i>Cyanea</i> (Ephyra-stage)	-	-	-	-	-	-	-	-	-	-	-

I Very Scarce.
 II Scarce.
 III Few.
 IV Fairly Common.
 V Common.
 VI Abundant.
 VII Very Abundant.

The "Arabic" figures
 show the actual number
 taken.

On the POWER of WITHSTANDING DESSICATION in PLANTS.

By ALFRED J. EWART, D.Sc., Ph.D.,
1851 EXHIBITION SCHOLAR.

[Read 12th February, 1897.]

THE statement that many seeds and spores as well as certain Mosses are able to withstand complete dessication without their vitality being destroyed is one which is frequently found in text books but which is nevertheless quite erroneous. In no case can anything of a vital nature, in whatever condition or however resistant it may be, be deprived of all water without, at the same time, destroying its vitality. Thus Schröder* has shown that seeds of *Hordeum* and *Triticum*, after being kept for 12 weeks over H_2SO_4 in a dessicator, were nearly all still capable of germination but contained, though apparently quite dessicated, from 1 to 2% by weight of water. Similarly with a Lichen *Sticta pulmonaria* which withstood 17 weeks dessication over sulphuric acid the minimal "Feuchtigkeitgehalt" consistent with the preservation of vitality was found to be 5% by weight of water.

In order to investigate more closely the relation between these two factors a series of experiments, the results of which are given below, were made. The plants or seeds are dried for long periods of time exposed to air or in a dessicator and then, after ascertaining how the vitality of the specimens has been affected by the prolonged drying, a sample is weighed and after heating to $100^{\circ}C.$ until no further loss of weight takes place, again weighed. The

* Schröder. Über die Austrocknungsfähigkeit der Pflanzen. Bot. Untersuch. aus Tübingen. Bd. II., Hft. 1, 1886.

last weight is the dry weight of the specimen and from it the percentage of water which was previously present can be calculated.

In experiments made with *Dicranum scoparium* the upper leafy portions of the stem were taken and kept air dried for 3 months at 18°C. to 20°C. The leaves and leaf cells are for the most part living, and on making cell preparations with Bacteria show in most cases as soon as examined but in others not till after the lapse of an hour or so, an active evolution of oxygen, *i.e.*, the absorption of water is almost immediately followed by a resumption of assimilation, even after so long a dormant period. If assimilation is active it is safe to conclude that respiration is active also. Direct evidence is also afforded by keeping the moistened plants in a gas chamber filled with air deprived of CO₂, along with a hanging drop of a weak alkaline solution of phenolphthalein or of an aqueous solution of BaH₂O₂. If 2 or 3 plants are used the drop of phenolphthalein commences to fade in 10—15 minutes, which indicates that the return of respiration is practically simultaneous with the absorption of water by the dried plasma. A sample of such dried plants contained 8·18% of water. After being dried in the dessicator at 35°C. for several days, until the weight shows no further appreciable diminution, the plants still contained 1·78% of water. Another sample of fresh plants, after being air dried for a few days, contained 15·88%, and after being in the dessicator at 35°C. until the weight remained constant contained 2·07%, of water.

Plants of *Cladonia rangiferina* kept air dried for 3 months at 15°C. to 20°C. are almost unaffected the gonidia being almost all living. If moistened and rapidly examined, at first no perceptible or only a mere trace of an evolution of oxygen is shown, but this after half-an-

hour is in most cases moderately active and in 1 hour quite active. The plants contained 14.55% of water, after being kept for 1 day at 45°C. they contained 6.9%, after 2 days 6.84%, after 3 days 6.76%, and after a 4th day at 50°C. they contained 5.56% of water. On comparing these results with those given in Table D., p. 376, in the Journal of the Linnean Society for 1896 (On Assimilatory Inhibition) it can be seen that there is a certain, though by no means proportional, relation between the loss of water and the inhibition of the power of assimilation.

Similar experiments with dried seeds show that there is a distinct relation between the loss of water and loss of germinative power. After 2 weeks drying in a dessicator at 20°C. followed by 2 weeks at 37°C. to 38°C., Wheat contained 2.67% of water and 91% of the seeds germinated (percentage before drying was 93%), *Lupinus albus* contained 1.88% of water and 94% of seeds germinated (of normal 95%) *Ricinus communis* contained 0.92% of water and 40% of the seeds were capable of germination (of normal 62%). *Zea mais* contained 2.5% of water and 88% of seeds germinated (of normal seeds 92%). Similarly with other seeds kept in a dessicator for 2 weeks at 20°C. and then for 6 weeks at 37°C. to 38°C., *Zea mais* contained 1.7% H₂O and 80% of the seeds were capable of germination (normal 92%), *Lupinus albus* contained 1.28% of water and 92% germinated (normal 95%), *Cucurbita pepo* contained 0.87% of H₂O and 90% germinated (of normal 94%). In the case of *Cucurbita* seeds the presence of a large external husk forming a large fraction of the weight of the seed forms a disturbing factor. If these were free of all hygroscopic water the actual seed would contain between 1% and 2%. It appears therefore that even with the most resistant of seeds it is impossible to reduce the percentage of water, held by the seed to lower than from

2% to 3% of the dry weight, without injuriously affecting their vitality.

One result of prolonged dessication, especially if the temperature be fairly high (38°C. for example), is to cause a prolonged inhibitory after-effect upon germination, which may be delayed many days or even weeks longer than normal. If the seeds are, previously to drying, killed by prolonged boiling, it is found that they lose water rather more readily than similar living seeds kept in cold water for the same length of time and then subjected to dessication. Thus such seeds of Wheat, Maize and Peas contained, when air dried, from 6% to 8% of water, whereas the living seeds contained from 10% to 12%. If dried for 10 days in a dessicator at 37°C. to 38°C. the dead seeds contained from 2% to 3% of water, whilst the living ones contained from 3% to nearly 5%. After being dried in the dessicator for from 6 to 7 weeks at 37°C. to 38°C., the dead seeds contained less than 1% of water whilst the living seeds contained from 1% to 2%. Similar results are obtained by seeds which are incapable of withstanding prolonged dessication, for here as the seeds die the percentage of water becomes gradually less and less. Thus air dried Hemp seeds contained 9% of water and 87% germinated; Haricots contained 15% of water and 84% germinated. After a week in the dessicator at 37°C. to 38°C. the Hemp seeds contained 1.43% of water and 47% remained capable of germination, the Haricots averaged 4.68% of water and 60% germinated. After 45 days in the dessicator at 37°C. to 38°C. none of the Hemp seeds formed seedlings, though in a few cases the radicles protruded and grew to a few millimetres in length, the percentage of water present was 0.64. The Haricots contained 1.1% of water and after a very long latent period 2% germinated.

It appears therefore that when ordinary resistant seeds are dessicated the lowest percentage of water which they can contain without their vitality being injuriously affected lies between 2% and 3% of their dry weight, as the percentage is reduced below this amount successively more and more of the seeds are killed. The fact that it seems to be impossible to remove this water, without, at the same time, destroying the vitality of the seed (or plant), suggests that the water may be associated in some manner, perhaps in a loose chemical combination, with the plasma of the seed. It is very probable, however, that the water held so tenaciously is merely capillary water for it is well known that excessively fine capillaries, such as the molecular or micellar interstices of an organized structure hold water with a very great force and offer a considerable resistance to its loss by evaporation. The fact that the dead seeds lost water more readily might be simply due to an alteration of the molecular structure, caused by the boiling, having taken place, for if the seeds are kept in water at 100°C. just long enough to kill them and no longer, it is found that they lose water when dessicated with but little greater rapidity than normal seeds do.

What is quite certain, is, that dry but vital plasma cannot possibly be of the same chemical composition as living active fluid plasma on the one hand, or as dead proteid on the other, but is probably intermediate between the two. The change from the fluid or colloid to the solid condition is, of course, a mere physical change directly due to the withdrawal of water, but induces a profound chemical change. Dry protoplasm is perfectly dormant, it can neither respire nor assimilate, add to its substance or diminish it. In the dry condition it is a stable and non-oxidizable chemical compound. According

to Latham* active living plasma consists of a chain of cyan alcohols united to a benzene nucleus and thus forming a body which is extremely unstable and very prone to molecular change. From this substance, by dissociation and re-arrangement, the various metabolic products of protoplasm can be derived. On drying, a re-arrangement of the protoplasmic molecule into a stable grouping, which may or may not be accompanied by dissociation, takes place. On the addition of water an extremely rapid re-combination and re-organization occurs, the unstable active living protoplasmic molecule being again produced and almost immediately commencing to respire and assimilate. The protoplasm of a plant, which is unable to withstand dessication, is probably resolved on drying into a stable series of substances from which, inter se, no re-organization of the protoplasmic molecule can take place. It is interesting to notice that no cell, the protoplasm of which shows streaming or rotation, can withstand dessication. It appears that where the vital activity of the plasma manifests itself in the form of rotation or circulation, the preservation of vitality is indissolubly connected with the presence of free fluid water in the protoplasm.

A cell is resistant to drying, when its protoplasm is readily stimulated by the loss of water to re-arrange its molecular grouping in a stable, and hence resistant molecular arrangement and one from which, at the same time, a re-awakening is possible. The re-awakening is normally very rapid and does not involve any appreciable latent period but in other cases a more or less prolonged latent period seems to intervene between the absorption of water and the complete resumption of vitality as evidenced by the return of respiration and assimilation. Here it is

* Latham. Brit. Med. Journal, Vol. I., 1886, p. 629.

quite possible that a more or less marked dissociation of the protoplasmic molecule into less complex substances has taken place and the latent period may be the expression of the time required for the completion of the necessary re-combinative changes, the energy supplied by the forcible re-absorption of water, affording the necessary stimulus. Where there is no perceptible latent period the dissociative changes have probably been only slight or absent, the change to the dry condition involving merely a rearrangement of the protoplasmic molecule. Where actual dissociation takes place, the less complex substances, one of which may be water in a combined form, into which the protoplasmic molecule is resolved, do not necessarily separate from each other but may remain within the spheres of attractive influence of their respective molecular groups so long as vitality is retained, falling asunder and losing the power of re-combination when vitality is lost.

Such dissociatory changes appear to take place when the amount of water present approaches to the minimum consistent with the preservation of vitality, and are hence produced by prolonged dessication or dry heat,* but they may occur even when the amount of water present is considerably over 10% of the dry weight, *viz.*, in Lichens or Mosses kept air dry for long periods of time, and normally in seeds on ripening and drying as instanced by the latent period of respiration shown by moistened seeds.†

Assuming the correctness of the above deductions, very plausible explanations can be offered of most of the phenomena observed in this connection. The "inhibitory after effect" is explained as being really a latent period of recovery. It is possible also to understand, in this light,

* Journal of the Linnean Society, 1896, p. 373—377.

† On Vitality of Seeds. Trans. L'pool Biol. Soc., Vol. VIII., 1894, p. 234.

why, of closely allied plants, the plasma of the one may be capable of withstanding dessication, that of the other not, the difference being due to the fact that the plasma of the more resistant form has acquired, by adaptive modification, the power of, when dessicated, re-arranging its molecules in a stable form from which recovery is possible, whilst in the other case the stable substance or rather substances into which the protoplasmic molecule resolves on drying are such that from them no re-constitution of the protoplasmic molecule is, *inter se*, possible.

In plants which can withstand dessication very varied degrees of resistance are shown. These differences are probably due to the fact that the protoplasmic molecule can, in some cases, retain the necessary molecular arrangement which permits of re-organization for a very long time, but in others, only for a limited period. Thus seeds of *Oxalis*,* *Salix*† and *Populus*‡ are killed by from 1 to 3 weeks air drying, and in many cases the duration of the drying is more important than its degree. The presence of oil in the plasma does not seem to make it more resistant to dessication, as Alex. Braun§ supposed, for Hemp seeds are less resistant than Peas or Barley and *Dicranum scoparium* is less resistant than *Orthotrichum affine* or *Bryum caespitium*. As Schröder (l. c.) points out, however, when the oil is coloured (lipochrome pigments, etc.) and present in microscopic organisms (many Palmellaceæ, etc.) it may be of importance as a protection against the decolourization which sunlight may induce in dried cells containing chlorophyll.

* F. Hildebrand. Über die Schutzeinrichtungen der Oxaliszwiebeln. Ber. d. D. Bot.-Gesell., 1884, Hft. 3.

† Wichura. Die Bastardbefruchtung der Weiden, 1865.

‡ Schröder, L. c. Nobbe. Handbuch der Samenkunde, 1876.

§ Alex. Braun. Betrachtungen über die Erscheinung der Verjungung in der Natur, 1850.

It is difficult at first to comprehend how many seeds, spores, and even Mosses, can withstand, in the dried condition, temperatures far above those necessary to coagulate coagulable albumen. Lewith* has, however, shown that the less water albumen contains, the higher is its coagulating point. Thus egg albumen containing 18% of water coagulates at 80°C. to 90°C., with 6% at 145°C. and with no water at 160°C. to 170°C. Hence assuming that dried plasma, though of much greater complexity, approaches to a certain extent to the nature of coagulable proteid, we can understand the greatly increased resistant power to heat which dessication gives, and yet can understand why the most resistant plasma has its vitality destroyed at temperatures far below that necessary to coagulate perfectly water free egg albumen.

* Ein Beitrag zur. Theorie der Desinfektion. Archiv. f. exper. Pathol., 1890, XXVI., p. 341.

[WORK FROM THE PORT ERIN BIOLOGICAL STATION.]

ADDITIONAL NOTES on the TURBELLARIA of
the L.M.B.C. DISTRICT.

By H. LYSTER JAMESON, B.A.

With Plates V. and VI.

[Read May 14th, 1897.]

IN this list, which is intended to supplement Mr. F. W. Gamble's Report (Trans. L'pool Biol. Soc., Vol. VII., 1893), I propose to record the Turbellaria which I found in the neighbourhood of Port Erin, during a couple of weeks I spent at the Laboratory of the Liverpool Marine Biology Committee in April, 1897.

During my stay at Port Erin I confined my attention to the marine species, the only fresh-water form that I am able to record being *Polycelis nigra*, a number of specimens of this Triclad having been found by Mr. A. R. Jackson, B.Sc., Science Student at University College, Liverpool, who kindly handed them over to me for identification.

Of the Marine species *Graffilla buccinicola* is new to science, seven Rhabdocoeles and one Polyclad are not recorded in Mr. Gamble's list; while two Polyclads and eighteen Rhabdocoeles, already recorded in his report, were also found by me.

I regret that the shortness of my stay at Port Erin allowed me but few opportunities of exploring new collecting grounds on the Manx coast; but Port Erin Bay and Port St. Mary supplied me with such a quantity of material, that I devoted all my time to these two places.

I must here express my gratitude to Mr. Gamble for his valuable advice as to the best localities for finding a

rich supply of material, and for many useful hints as to collecting and identifying my specimens.

As to the occurrence of the species: the commonest Rhabdocoele by far was *Macrorhynchus croceus*; *Monotus lineatus* and *M. fuscus* coming next in number of individuals. The two latter, taken together, hardly outnumbered the former, while to these three species belonged about half of the Turbellarians I examined. Of the remaining types the commonest were *Pseudorhynchus bifidus*, *Byrso-phlebs intermedia*, *Promesostoma agile*, *Provortex balticus*, and *Macrorhynchus heligolandicus*.

My experience of the Parasitic Rhabdocoeles is limited to the new *Graffilla*, which occurred in numbers in the kidney of almost every *Buccinum undatum* and *Fusus antiquus* that I examined. The "Cocoons" of *Fecampia erythrocephala* were not uncommon between tide-marks, but I searched in vain for the worm itself.

TURBELLARIA.

I. TRICLADIDA.

Polycelis nigra, O. F. Müller.

New to Isle of Man fauna.

Nine examples of this very common species were found by Mr. A. R. Jackson in a small stream near Port Erin. They measured from 6 to 14 mm. in length and were of a particularly deep black, showing none of the variations so common in this species, which is frequently coloured brown or grey, and presents all gradations from these colours to black.

II. RHABDOCOELIDA.

A. ACOELA.

Aphanostoma diversicolor, Oersted.

Two examples, among seaweeds collected at low tide near Port Erin Breakwater.

Three specimens of an acoelous type, probably an *Aphanostoma*, in which no trace of gonads or genitalia was visible were taken by tow-netting in Port Erin Bay.

Convoluta paradoxa, Oersted.

One example only was found, in some seaweeds gathered at low-water opposite the Biological Station. This individual measured 2 mm. in length, and presented no trace of the transverse bars which sometimes occur.

B. RHABDOCOELA.

Family MESOSTOMIDÆ.

Promesostoma marmoratum (Schultze).

Two specimens taken in tidal pools near the biological station had the usual dark reticular pigment between the eyes. Five others found among seaweeds between tide-marks near the Breakwater were without reticular pigment, but provided with copious yellowish-red colouring matter in the epidermis, resembling the variety that v. Graff records from Naples (Monographie, p. 270).

Promesostoma solea (O. Schmidt).

Although Gamble does not record this species in his paper (4), he gives Port Erin as a locality in the list of British species which he has appended to his article on the Turbellaria in the Cambridge Natural History (vol. ii., p. 49). I procured two specimens at low water, among seaweeds, in front of the biological station.

This species can at once be distinguished from *P. ovoideum* (O. Schm.), by the presence of a curious process of the pigment-cup, which extends outwards over the lens of the eye.

My two specimens differed considerably in the density of their body pigment, in one it was as dense as in v.

Graff's figure of *P. ovoideum* (Monogr. Tab. vii., fig. 11), but not extending right to the anterior and posterior ends of the body, and thinning off between the eyes; in the other specimen it was altogether more diffuse. Length of both specimens .6 mm.

Promesostoma agile (Levinsen).

New to L.M.B.C. District.

I obtained seventeen specimens of this worm among seaweeds collected at low tide on Port Erin Breakwater. They varied from .35 to .6 mm. in length. Colour, light red. The penis was in most of my specimens more strongly curved at the apex than it is in Gamble's figure (3, pl. xl., fig. 14), in some few it is even more so than in Levinsen's sketch (10, Tab. iii., fig. 5), but it is evident that this feature is one that varies.

I have in vain tried to make out the relations of the "receptaculum" in this species, the organ is visible behind the atrium in all specimens, and has a club-shaped appearance, but I can find no connexion between this structure and the other genitalia, nor am I quite clear as to the normal position of the genital atrium itself. These points can only be cleared up by the study of sections.

Very typical of this species are several very large granular salivary (?) glands, with ducts which converge just behind the pharynx, they do not seem to have been observed before.

Byrsophlebs intermedia, v. Graff.

Common on *Cladophora* collected in tide-pools near the biological station.

Proxenetes flabellifer, Jensen.

One specimen among *Cladophora*, in a rock-pool near the station.

Mesostoma neapolitanum, v. Graff (Pl. V., fig. 1).

New to L.M.B.C. District.

Under this name I introduce a single specimen, found among seaweeds collected between tide-marks at Port St. Mary, which conforms in all essential details with the descriptions of v. Graff and Gamble.

Length 6 mm., white, gut slightly discoloured by yellowish food-stuff. Pharynx central (not in front of centre as described by v. Graff and Gamble, but this difference is perhaps due to unequal contraction in my specimen). Rhabdites very densely distributed in anterior end, forming two very well marked lines between the eyes: The eyes are small and reniform, provided with lenses, body pointed in front, rounded behind, genital pore close to posterior end of body. Testes lateral, elongated; seminal vesicle kidney shaped, the penis being attached to the concave side (fig. 1). Penis consists of a proximal muscular portion and a distal chitinous tube which is slightly more curved than in v. Graff's figure. The atrium is extremely large and conspicuous, copiously supplied with glands.

The female reproductive organs were not developed in my specimen. It is strange that in all the recorded occurrences (as far as I am aware) of this species, viz., von Graff's (Monographie, p. 310), Gamble (3), p. 26, and the present note, only single specimens have been found. I have preserved this specimen as a microscopic preparation, by Dr. M. Braun's method. ("Die Rhabdo-coeliden Turbellarien Livlands"; Archiv. f. d. Naturkunde Livlands, &c., Bd. X., 1885.)

Family PROBOSCIDÆ.

Pseudorhynchus bifidus (M'Intosh).

Common between tide-marks at Port Erin and Port St. Mary. Some of those found on the Breakwater measured as much as 2.2 mm. in length, although v. Graff gives

1.7 mm. and Gamble 1—1.3 mm. as usual size. The number of turns in the spiral on the chitinous penis varied between six and seventeen. The spiral was right-handed in all the examples that I examined. The bursa, which has a delicate chitinous lining, was very obvious in some of the specimens I examined; it has been accurately figured by Jensen (7, Tab. iv., fig. 12).

When disturbed this worm retreats rapidly backwards in a very characteristic manner, attaching itself by its adhesive tail and drawing the body up, the movement being repeated in a leech-like manner.

Acrorhynchus caledonicus (Claparède).

Port Erin Breakwater, two specimens; Port St. Mary, between tide-marks, three specimens.

Macrorhynchus nägelii (Köl liker).

Among seaweeds at low-water opposite the biological station, six examples.

Macrorhynchus croceus (Fabricius).

New to L.M.B.C. District.

This species was the commonest Turbellarian during my stay at Port Erin; numerous specimens, from fully grown individuals with a ripe egg capsule in uterus, to young ones in which the gonads were only appearing, being found in every piece of seaweed examined, both from Port Erin and from Port St. Mary. I have been unable, although I had exceptional opportunities, to make out from pressure preparations the relations of the female gonads to the atrium, but I hope to be able to throw some light upon this question by the examination of sections of some specimens which I preserved for this purpose.

Macrorhynchus heligolandicus, Metschnikoff.

Occurred at Port St. Mary and at Port Erin among seaweeds, and in tide-pools.

Family VORTICIDÆ.

Provortex balticus (Schultze).

Common in tide-pools at Port Erin. A large proportion of those examined had ripe eggs in their uteri. A variety without the usual brown pigment was found along with normally coloured individuals among *Cladophora*.

Provortex affinis (Jensen).

New to L.M.B.C. District.

One example, among *Cladophora* in a tide-pool near the station. This species is easily distinguishable from *P. balticus* by the form of its penis, the distal part of the chitinous tube bending at an angle to the proximal part and bearing a leaf-like triangular plate.

Fecampia erythrocephala, Giard.

Gamble gives Port Erin as a locality for this parasitic form in the Cambridge Natural History, vol. ii., p. 50, although at the time of his publishing his paper in these "Transactions" he had not met with it.

I found numerous "cocoons" of this species under stones between tide-marks, but I failed to find the worm itself in any of the *Carcini* that I examined.

Graffilla buccinicola, n. sp. (Pl. V., figs. 3 to 6; Pl. VI., figs. 7 to 13).

The above name I propose to give to a parasite from the kidney of *Buccinum undatum* and *Fusus antiquus*, which I found infesting these two molluscs in considerable numbers. The genus *Graffilla*, von Jhering (8), was established to receive a species found in the kidney of *Murex*, which v. Jhering called *Graffilla muricicola*. To the same genus a parasite discovered by Lang (9) was referred by v. Graff (Monographie, p. 375) who called it *G. tethydicola*. V. Graff also refers the *Anoplodium mytili* of Levinsen (10) to this genus. Finally a fourth species was described by Dr. Ferdinand Schmidt (Archiv. für

Naturgesch. v. lii., pt. 1, p. 305, 1886), from the liver of *Teredo*, under the name of *Graffilla braunii*. A valuable account of the anatomy of the first two species is given by Böhmig; (2). The genus *Graffilla* has not hitherto been found in British waters.

DESCRIPTION:—Length 1—2.5 mm. Breadth .5—1 mm. Colour greyish yellow to reddish yellow, very opaque, in favourable pressure preparations groups of olive brown pigment granules (fig. 5) are visible evenly distributed over the body. Sections prove that they are situated in the parenchyma. Form, cylindrical in section; outline of body varies according to condition of genital glands; in small, 1—1.8 mm. long individuals, in which male organs alone are visible, it is elongate with the greatest breadth behind middle of body, and posterior third tapered off into a tail; in larger specimens with ovaries and yolk glands highly developed the general outline is stouter, and the "tail" usually cannot be recognised (fig. 6).

Mouth on ventral aspect of anterior end of body, being in fact an excellent example of a terminal mouth. It leads into a pharyngeal sack, quite obvious in all sections of well preserved specimens, in which lies the small doliiform (v. Graff) pharynx, which can be protruded by the living animal to a certain extent. The pharynx measures $\frac{1}{12}$ — $\frac{1}{15}$ of total length of body.

Nothing comparable to the "Haftapparat" of Böhmig is present in this species. The interior of the pharyngeal sack is not ciliated. Eyes, two; small, reniform, provided each with three or four small lens cells, they are completely buried in the substance of the brain as will be seen in fig. 7. The body is uniformly ciliated, the cilia are short and comparatively thick, the cuticular layer of the epidermis is also thicker than is usual among the Turbellaria. Around the mouth I observed a few cilia longer than

the others and non-motile, they are presumably tactile. No rhabdites were to be observed in the skin although in living specimens pressed on the slide a considerable amount of viscid mucous matter was extruded from the epidermis. I have found no trace of the epidermal glands so characteristic of *Graffilla tethydicola*.

There is an outer circular and an inner longitudinal muscle layer. The pharynx passes off into a well marked œsophagus (fig. 8). The œsophagus soon widens out into the very extensive gut, which has histologically the characters described by Böhmig. The extent of the lumen of gut depends upon the amount of food recently absorbed by the cells, and may be said to vary inversely as the amount of granules and vacuoles in the gut cells themselves. The gut occupies the whole volume of the animal's body posteriorly to the germ glands or testes, excepting the small space left between it and the body wall, in which the great yolk glands ramify.

The genital opening is a very short distance behind the mouth, approximately on a level with the posterior opening of the pharynx, so that in a section it is possible to get the eyes, the genital opening and the posterior end of the pharynx in the same plane, as was actually the case in the specimen from which fig. 7 is copied. The whole relations of the genital organs are so exceedingly variable according to the age of the particular specimen examined that they will require separate descriptions, just as if the worm was of separate sexes.

This *Graffilla* presents one of the most extreme cases of successive hermaphroditism with which I am acquainted among the Turbellaria, specimens which present traces of both male and female organs being very unusual. In specimens measuring 1—1·8 mm. the male organs are generally predominant, the most conspicuous organ is the

large seminal vesicle about twice as long as the pharynx, and lying just posterior to it. It completely conceals the atrium in pressure preparations, but the relations of the various parts have been drawn from a section in fig. 8. Here we see the penis projecting into the atrium; and the diverticulum which will afterwards form the seminal receptaculum lying ventral and posterior to the seminal vesicle. The testes are lateral, they extend forward to the level of the seminal vesicle, with which they communicate by short ducts opening into the posterior end of the vesicle. Posteriorly they do not quite reach back to the middle of the body (fig. 3).

The penis is very difficult to observe, but my examinations of pressure preparations which I have been able to confirm by sections shew it to be a short thick tube, strengthened by several cuticular rings and capable of being retracted so as to appear as a rosette shaped organ on anterior end of seminal vesicle (fig. 10), or of being protruded as shown in figs. 11 and 13. The distal rings appear to be provided with fine serrations. I have not been able to make out the mechanism by which the penis is thus protruded.

In large individuals, in which the female organs are fully developed the testes and seminal vesicle together with the penis have atrophied and cannot be found either in pressure preparations or in sections. In one or two lucky pressure preparations I had the good fortune to find the seminal vesicle persistent, and the testes still visible; in these specimens the germ glands were not mature, and the yolk glands were much less extensive than in the majority of cases.

In the typical "female" condition the receptaculum seminis is large, spherical, and lies dorsal and posterior to the atrium (figs. 4 and 12) which is provided with uni-

cellular shell (?) glands. The germ glands lie entirely in the anterior third of the body, their proximal ends converging forward to open into the posterior part of the atrium in company with the yolk glands. Their distal halves are bent at an acute angle to the proximal halves, the apex pointing forwards and upwards, so that in a pressure preparation the glands present the appearance of two V's, one on either side of the body, occupying much the position that the testes formerly did.

In minute structure they conform to the type which is so distinctive of *Graffilla*, the individual ova being somewhat flattened and suggesting rouleaux of coins. The ducts of the yolk glands lie internally (mesiad) to the germaria and open into the posterior wall of the atrium. A short distance behind the atrium they branch, and by complex branching and anastomosing form a more or less complete sheath around the gut extending from the brain to the tail (fig. 4). Underneath the epidermis is the same extraordinary system of supposed excretory tubes that has been observed in other species of the same genus. They ramify and anastomose all over the dorsal surface in a most complex manner; and, as in the other members of this genus, no flame cells are visible. On either side of the body, running from anterior to posterior end, is a larger tubule, which presents a slight dilatation about the middle of its length.

The chief characters which distinguish this species from the other four members of the genus, are the position of the genital pore, the form of the germ gland and the penis, and the possession of pigment spots in the parenchyma. From *G. muricicola* it differs in the absence of Böhmig's "Haftapparat" or "Bohrapparat," in the form of the body, the position of the genital opening, the form of the germ glands, the fact that the eyes are embedded

in the brain, &c. From *G. tethydicola* it is at once distinguishable by the possession of eyes, and absence of the very striking epidermal glands. *G. braunii* also possesses the "Haftapparat," while the "excretory" tubules are very distinctive, the testes are in front of the atrium, the germ glands also present quite different relations. With regard to *G. mytili*, as since Levinsen (10) published his original description no specimens have been found, its position is doubtful, but Levinsen's description supplies quite enough details to prove that it is distinct from the worm I am describing. "Ovaria longa, sacciforma intra margines laterales sita" is sufficient in itself to distinguish *G. mytili* from *G. buccinicola*, to say nothing of the further statement in the Danish text, where he describes it as extending itself along the side of the body from the eyes far backwards, as a pair of broad sinuous sacks. His sketch and description of the seminal vesicle and penis have also no resemblance to the same structures in my species.

HABITAT :—In the kidney and renal duct of *Buccinum undatum* and *Fusus antiquus*. The greater number of specimens of both these molluscs were infected, the number of parasites in one host varied between four and several dozen. A few worms were generally present in the mantle cavity as well, into which they had probably escaped through the renal aperture. The movements of this species are sluggish, like the other members of the genus it frequently lies on its side with the body dorso-ventrally flexed and swims round in a circle. From my observations upon living examples, kept in sea-water, I find that it is extremely sensitive to light, hiding under any object that is put into the vessel with it.

As the specimens of *Buccinum* which I examined were procured from the fishermen (who use them as bait), and

had been out of the water for a couple of days before I received them, I cannot say whether the host suffers serious consequences from the attacks of the parasites; the kidney, in many cases, was distended, and contained a large quantity of mucus, and its walls seemed to be locally attenuated, being almost transparent in places.

LOCALITY :—Port Erin, Isle of Man.

C. ALLOIOCELA.

Family PLAGIOSTOMIDÆ.

Plagiostoma koreni, Jensen.

New to L.M.B.C. District.

Four specimens occurred among seaweeds collected in tide-pools near the biological station.

Body oval, pointed behind, rounded in front, broadest about the middle. Colour, under a low power or pocket lens, greyish white with a broad dark band across the body about the middle. The colour is due to two kinds of pigment, a dark brown reticular pigment in the parenchyma, which corresponds to the dark zone; and a lighter brown granular pigment in the epidermis, which, although denser in the middle of the body, extends to the head and tail as well.

The eyes are very variable in form, carmine red, and as far as I can make out have no lens. One of my examples presented a particularly beautiful variation in the form of the eyes. Here they were triangular, carmine red, with a violet spot in the centre which sent processes of the same colour to the three angles. I am inclined to believe that in this species we have an eye of the *Monotus* type, *i.e.*, a simple mass of pigment without lens.

Plagiostoma vittatum (Frey and Leuckart).

One specimen in a pool near the biological station,

colour distribution as in v. Graff, Monographie, Tab. xxii., fig. 6, f.

Vorticeros auriculatum (O. F. Müller).

Three specimens among seaweeds, opposite the biological station.

An individual 1.8 mm. long was taken in the tow-net by Mr. A. R. Jackson, at sunset on the 26th April in Port Erin Bay.

Cylindrostoma quadrioculatum (Leuckart).

A few specimens among *Cladophora*, collected in shallow rock pools near high-water mark, beside the biological station. This species seems particularly sensitive to light, and only appeared at the surface of the vessels, in which I put the *Cladophora*, after dark.

Family MONOTIDÆ.

Monotus lineatus (O. F. Müller).

Port Erin and Port St. Mary, very common among seaweeds collected between tidemarks.

In the great majority of the specimens that I examined the eye spot had the form of an irregular semilunar patch of pigment, such as is figured by Boeck (7), Pl. F., figs. 2, 6 and 9, or by von Graff (6), Tab. xx., fig. 18. One individual, however, taken at Port St. Mary presented such an extreme reduction of the "eye" that I have figured it (Pl. V., fig. 2). Here it is merely represented by a faint row of granules, forming a semicircle in front of the otolith.

Monotus fuscus (Oersted).

Common in tide-pools, and among tidal refuse, at Port Erin. Also found at Port St. Mary, but nowhere was it quite so numerous as *M. lineatus*.

III. POLYCLADIDA.

A. ACOTYLEA.

Family PLANOCERIDÆ.

Stylochoplana maculata, Quatrefages.

New to L.M.B.C. District.

Two specimens, under stones, at low-water, in front of the biological station.

Length of my two specimens 11 and 13 mm. respectively, body elongated; broad and leaf-like in front, tapering behind. Tentacles in the first fifth of body, the base of each is surrounded by a circle, which in examination of the living animal suggests a thickening of the epidermis, and gives one the idea of a depression into which the tentacle can be partly retracted. Five to seven eyes on base of each tentacle; between tentacles, and running toward anterior margin are two groups of eight or nine eyes, besides which, one of my specimens showed several minute black specks intermixed with these intertentacular eyes.

Colour, to naked eye, greyish brown; under microscope the ground colour is yellowish-brown, with darker spots, and a number of large white blotches, very well developed in one specimen, but smaller and less clearly marked in the other. Two genital openings are present.

I kept both specimens under observation for some hours, and noted that they swim with dorso-ventral flexion of the whole body, much as the medicinal leech does; and if disturbed, when creeping on the wall of the vessel, they retreat with a curious wriggling movement, which is produced by the alternate use of the two sides of the anterior end of the body; the left anterior corner being extended, and the body drawn up, when immediately the right side is pushed forwards and the process repeated

alternately by the two sides, the worm literally dragging itself along "hand over hand."

Verrill has suggested the generic name *Heterostylochus* for this species, considering that by the possession of two genital openings it has a right to generic distinction. (Trans. Connecticut Acad., vol. viii., 1892, p. 467.)

Family LEPTOPLANIDÆ.

Leptoplana tremellaris (O. F. Müller).

Several specimens, under stones, at Port St. Mary and Port Erin.

B. COTYLEA.

Family EURYLEPTIDÆ.

Cycloporus papillosus, Lang, var. *lævigatus*, Lang.

Two specimens at Port St. Mary under the same stone one of which measured 13·5 the other 11 mm.

Two found by Prof. Herdman, adhering to a colony of *Botrylloides* outside Port Erin Harbour, length 9 mm. and 6 mm. respectively. I have not had sufficient experience of this species to say whether this marked difference in size between the two individuals which usually consort together is or is not constant; further observations upon this point will be of interest, as it is possible that these couples which are so frequently found together represent stages in which the male and female elements are respectively at the maximum of development.

The relation between *Cycloporus* and the Ascidians with which it is so frequently associated is also a mystery, whether *Cycloporus* eats the Ascidian or merely derives moisture from it during the period it is exposed by the tide remains to be determined.

POSTSCRIPT :—Since the above was written I have found

a previous record of *Stylychoplana maculata* and of *Fecampia erythrocephala* for the district. Report Brit. Assoc., 1894. Proc. Sect. D, p. 318. *Fecampia* has also been recently observed at Plymouth by Mr. Garstang; (Journal Marine Biol. Assoc., vol. iii., p. 217).

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-

EXPLANATION OF PLATES.

PLATE V.

- Fig. 1. Penis of *Mesostoma neapolitanum*, v. Graff. v.s., seminal vesicle; ch., chitinous tube which projects into the spacious atrium.
- Fig. 2. Anterior end of variety of *Monotus lineatus* (O. F. M.), with greatly reduced eye spot. e., eye; ot., otolith; g., gut; t.c., tactile cilia on anterior margin.
- Fig. 3. *Graffilla buccincola*, n. sp., from a pressure of preparation, the male organs are developed in this individual. ep., epidermis; ph., pharynx; e., eye; s.gl., salivary (?) glands; g., gut; te., testis; v.s., seminal vesicle; pe., penis.
- Fig. 4. Anterior end of an individual in which the female elements are developed. ger., germ gland; y., yolk gland, which is not figured on the right side of the sketch; at., atrium; r.s., receptaculum seminis; other letters as in fig. 3.
- Fig. 5. Pigment spots, composed of groups of granules, from the subcutaneous parenchyma of *G. buccincola*.
- Fig. 6. Four sketches, to illustrate the variations in form, of *G. buccincola*. a. and b., examples in the

male stage; *c.* and *d.*, do. in female stage;
ph., pharynx; *v.s.*, seminal vesicle; *g.*, gut;
ov., germ gland.

PLATE VI.

Fig. 7. Transverse section through region of brain of *Graffilla buccinicola*; *ep.*, ciliated epithelium; *br.*, brain; *ph.*, pharynx (posterior end); *at.*, genital atrium; *g.o.*, genital pore; *e.*, eye.

Fig. 8. Longitudinal section of specimen with male organs developed. *ep.*, epidermis; *r.m.*, circular muscles; *l.m.*, longitudinal muscles; *br.*, brain; *ph.*, pharynx; *oe.*, oesophagus; *ph.s.*, pharyngeal sack; *g.o.*, genital pore; *r.s.*, rudiment of receptaculum seminis; *p.*, penis; *v.s.*, seminal vesicle.

Fig. 9. Transverse section of *G. buccinicola* in the female stage, passing through body near the apex of the loop formed by the germ glands. *g.c.*, cavity of gut; *ger. p.*, proximal limb of germ gland; *ger. d.*, distal do.; *y.*, yolk gland.

Fig. 10. Seminal vesicle with penis retracted.

Fig. 11. Do. penis protruded, from the same specimen under higher pressure.

Fig. 12. Scheme of relationships of the female apparatus constructed from sections. *at.*, atrium; *r.s.*, receptaculum seminis; *sh. gl.*, shell glands; *ger.*, germ glands.

Fig. 13. Penis, strongly magnified, from a pressure preparation.

OBSERVATIONS regarding a FOOTPRINT from the
KEUPER SANDSTONE at STORETON; with
a note on the probable structure of the foot by Prof.
H. G. Seeley, F.R.S., F.G.S., &c.

By H. C. BEASLEY.

With Plate VII.

[Read January 15th, 1897.]

THE footprint, in question (Pl. VII., fig. 1), is the natural cast, in relief, of the impression of a short broad foot, armed with strong claws, measuring about one inch in total length and slightly less in breadth, and came from the well known footprint bed on the east side of the south quarry at Storeton, Cheshire. After reading a paper before the Brit. Assoc. at their Liverpool Meeting, I pointed this out as one of the most perfectly preserved examples I had found, and Prof. Seeley very kindly examined it with great care and afterwards wrote to me as follows:—

“I find it to show five digits with the claws all turned outwards. The fourth and fifth are close together, and what I regard as the impression of the fifth digit is very shallow, as though its claw were indicated by the triangular paper pointer gummed upon the original slab. I take the outward direction of the claw probably to indicate a burrowing habit like that of the *ornithorhynchus*, and therefore an animal with long body, short legs, and shoulder girdle, and humerus of the *Monotreme* type, though the same conditions would be found in the *Anomodont*. The impression of the digits is well defined and seems to me like what I figured in the *Phil. Transactions*, 1888, pl. 76, as found in a *Dicynodont* named *Keirognathus* in the short broad form of the foot. The impression of the thin fleshy pad of the foot shows some of the carpal bones, on the hypothesis that the foot is a

fore foot. In the carpal region there is on each side an indication of a slight lateral expansion of the foot (Pl. VII., fig. 2). On the inner side, in the middle of this expansion, appears to be a small digit, possibly with three bones, corresponding to the structure which Prof. Karl Bardeleben of Jena has described in some small mammals and named the pre-pollex (Pl. VII., fig. 2, *p.p.*) It extends inwards like a spur. On the outer side there is a corresponding structure, most faintly impressed, which in the language of Bardeleben represents the second bone of the pisiform element of the carpus on the outer side (Pl. VII., fig. 2, *2.p.*) There appear to me to be five bones in the distal row of the carpus."

It will be noticed that Prof. Seeley is very cautious in his remarks, and the observations on this particular footprint would have to be confirmed by the examination of other examples before any certain conclusion could be pronounced. It seems probable, however, that the footprint may indicate the presence of anomodont reptiles in our district in triassic times, and should it be found possible to identify any of the footprints found as those of a certain family, if not genus, quite a new field would be opened for the study of the ancient fauna of our district hitherto so very uninteresting to the palæontologist.

The fact that the presence of several species of *Dicynodon* in the trias of Elgin has been clearly proved within the last few years, lends probability to the theory of their existence at the same time in this district. The presence of osseous remains seems so far restricted to a very few localities in Great Britain, whilst the footprints are far more widely spread, and there is every reason to suppose that the non-preservation of the bones is due to the condition of the material in which they were embedded and not to absence originally. The remains found at

Elgin were mainly represented by hollow spaces in the sandstone which were really the moulds of the bones whose substance had been dissolved away, the sand itself having sufficiently consolidated to retain their forms. If, however, the solution was complete before the solidification of the matrix then all traces of the presence of the bones would have been lost, and this is probably the reason of any trace of bones or teeth being so rare to this district.

Any similarity between the fauna of the trias of this country and that of South Africa or elsewhere is a matter of interest as regards the distribution of animals. Where change of conditions depends on change of temperature such change will be gradual and the conditions will move continuously in a direction more or less directly north and south, and the fauna and flora will readily follow.

It is, however, generally supposed that the triassic formation represents arid and desert conditions, due to the cutting off of moisture bearing winds by the elevation of a mountain chain or otherwise. These conditions would arise in totally disconnected areas where the fauna and flora migrating from one locality to another would have to cross tracts of country where other conditions would prevail placing them at a considerable disadvantage in the struggle for existence; and much modification might be expected in those forms that survived and happened to reach the new locality where conditions had arisen to which they were originally fitted.

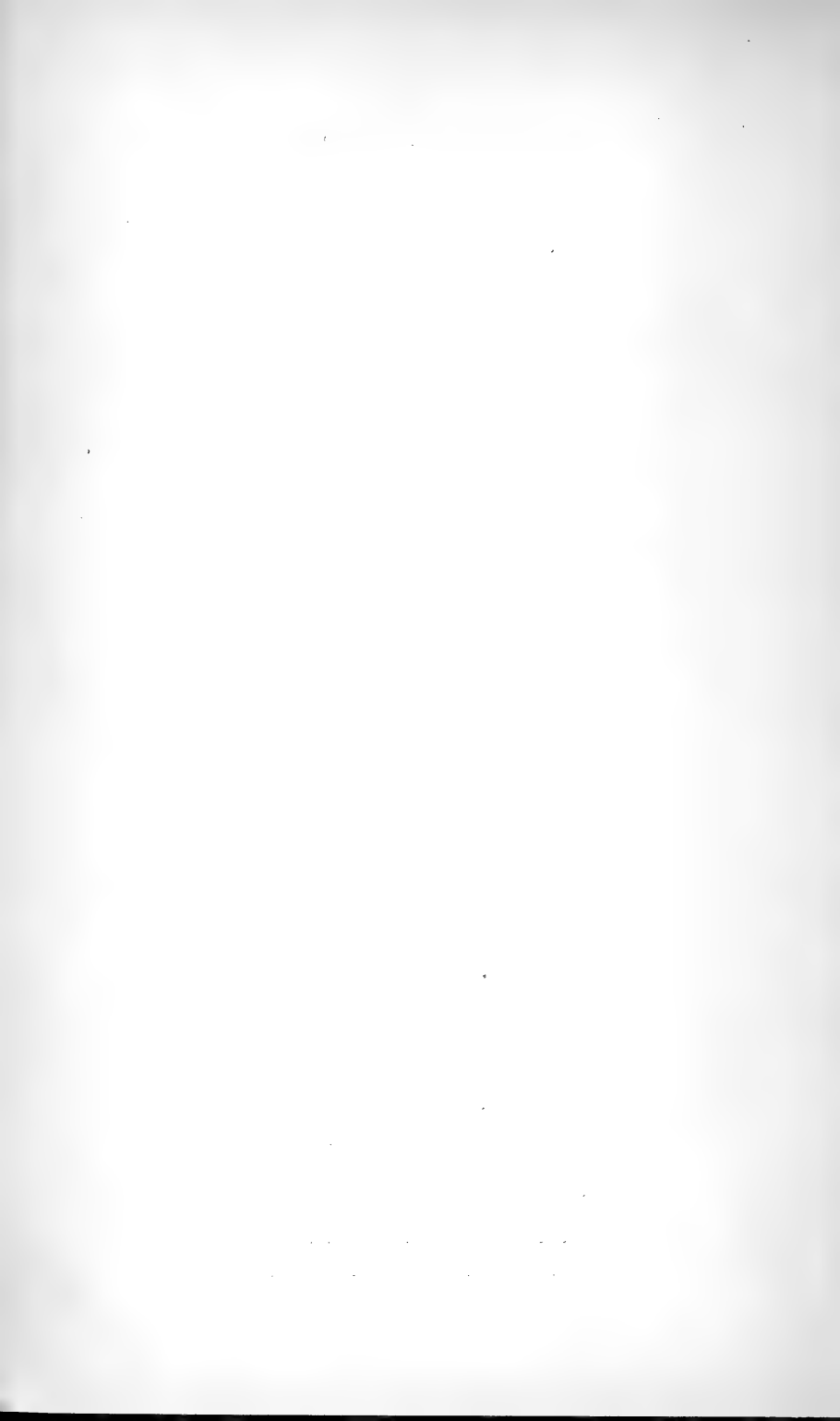
EXPLANATION OF PLATE VII.

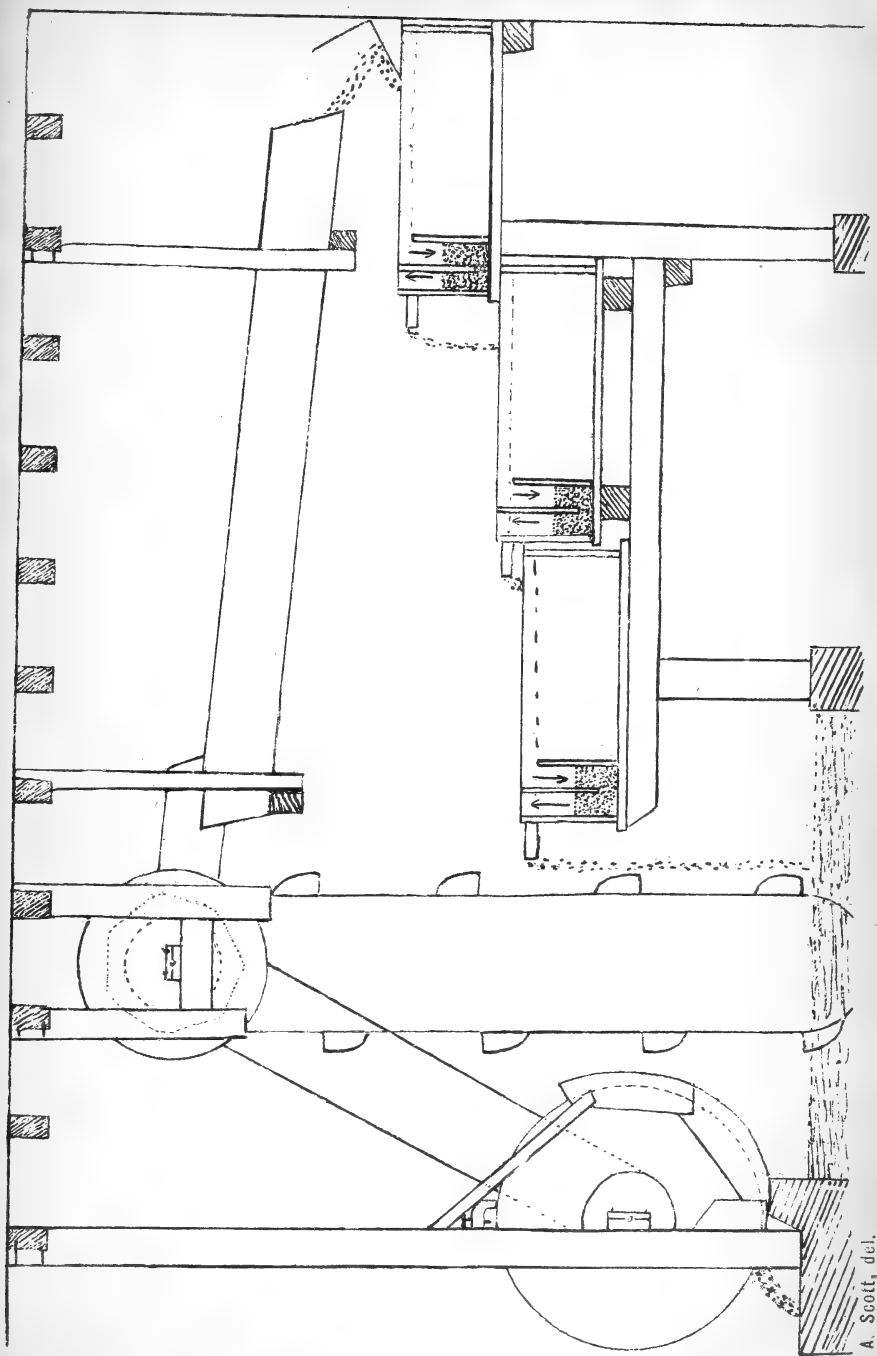
Fig. 1. Natural Cast of a footprint from the Lower Keuper Sandstone of Storeton, Cheshire.

Fig. 2. Drawing from the same showing the characters seen by Prof. H. G. Seeley.

p.p. Prepollex.

2.p. Second bone of the pisiform element of the carpus on the outer side.







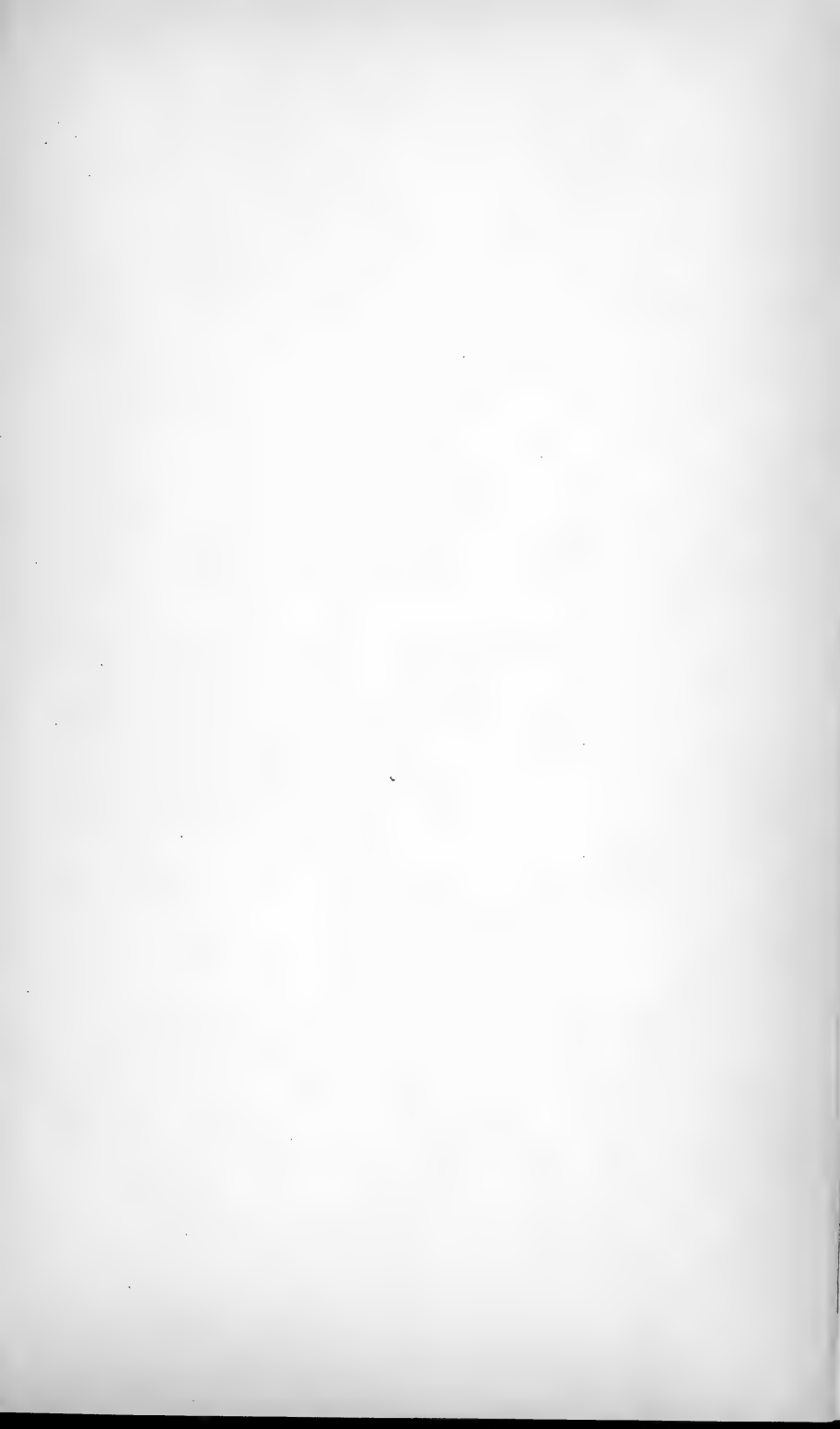


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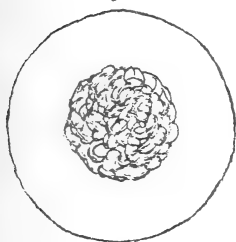


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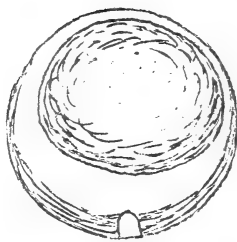


Fig. 3.

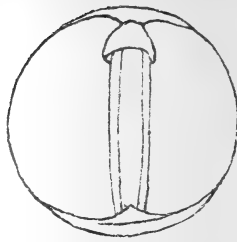


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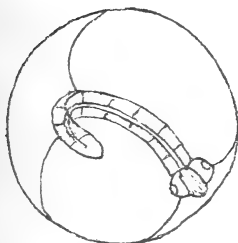


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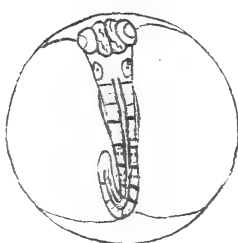


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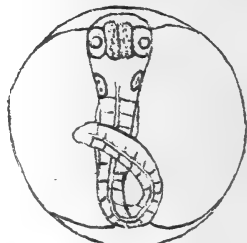


Fig. 7.

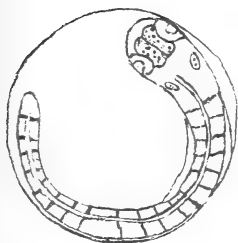


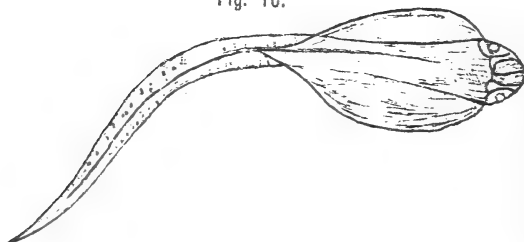
Fig. 8.



Fig. 9.



Fig. 10.



A. Scott, del.

LEMON SOLE AND WITCH.

Fig. 1.

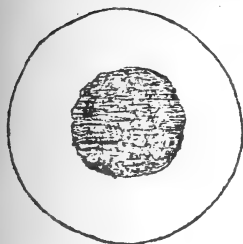


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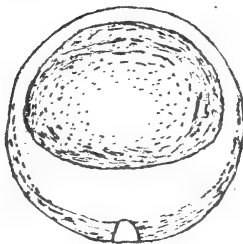


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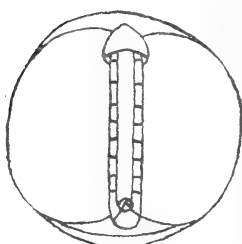


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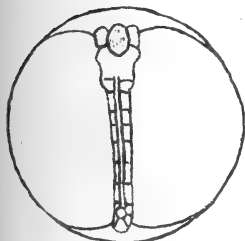


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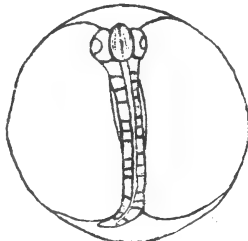


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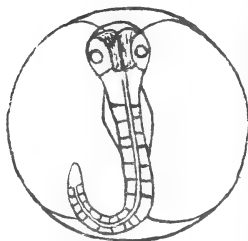


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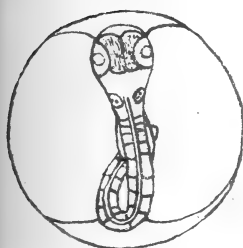


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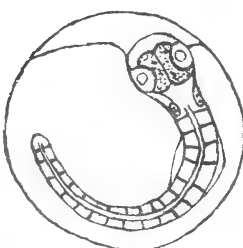


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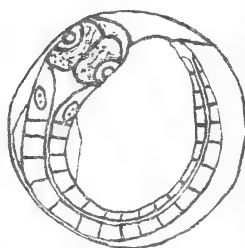
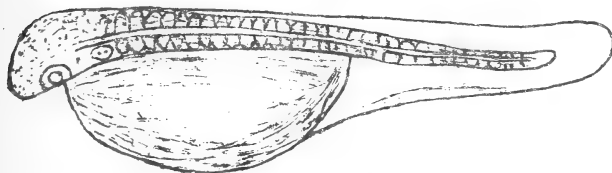


Fig. 10.



A. Scott, del.

WITCH.



Fig. 1.

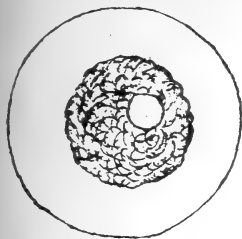


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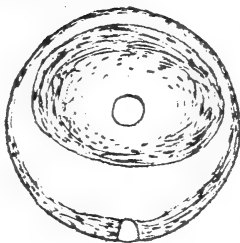


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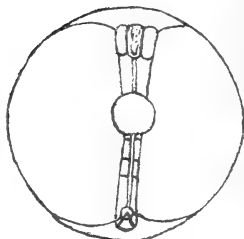


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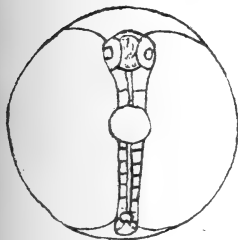


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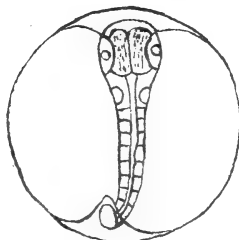


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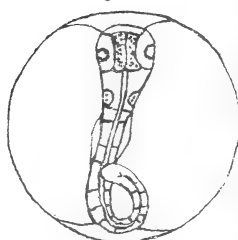


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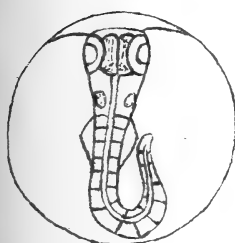


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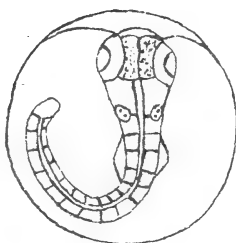


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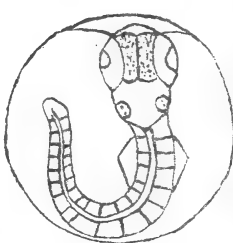
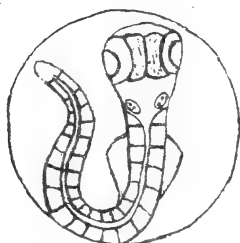


Fig. 10.





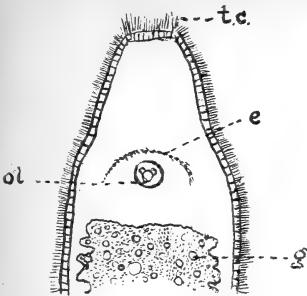


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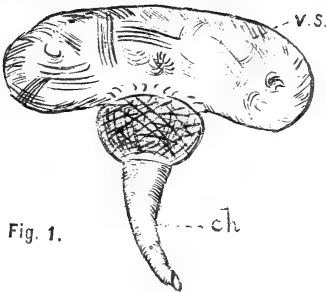


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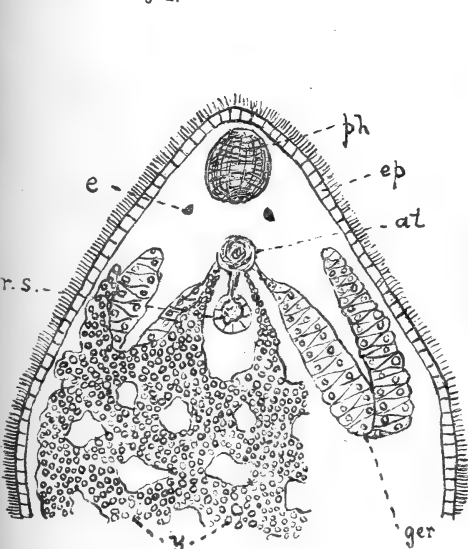


Fig. 4.

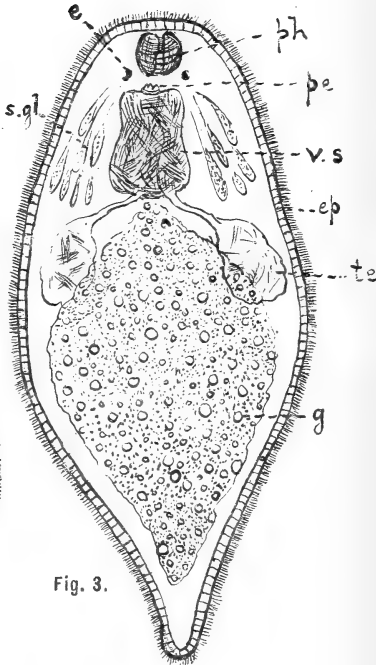


Fig. 3.



Fig. 5.

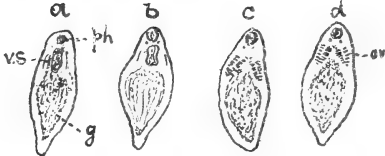
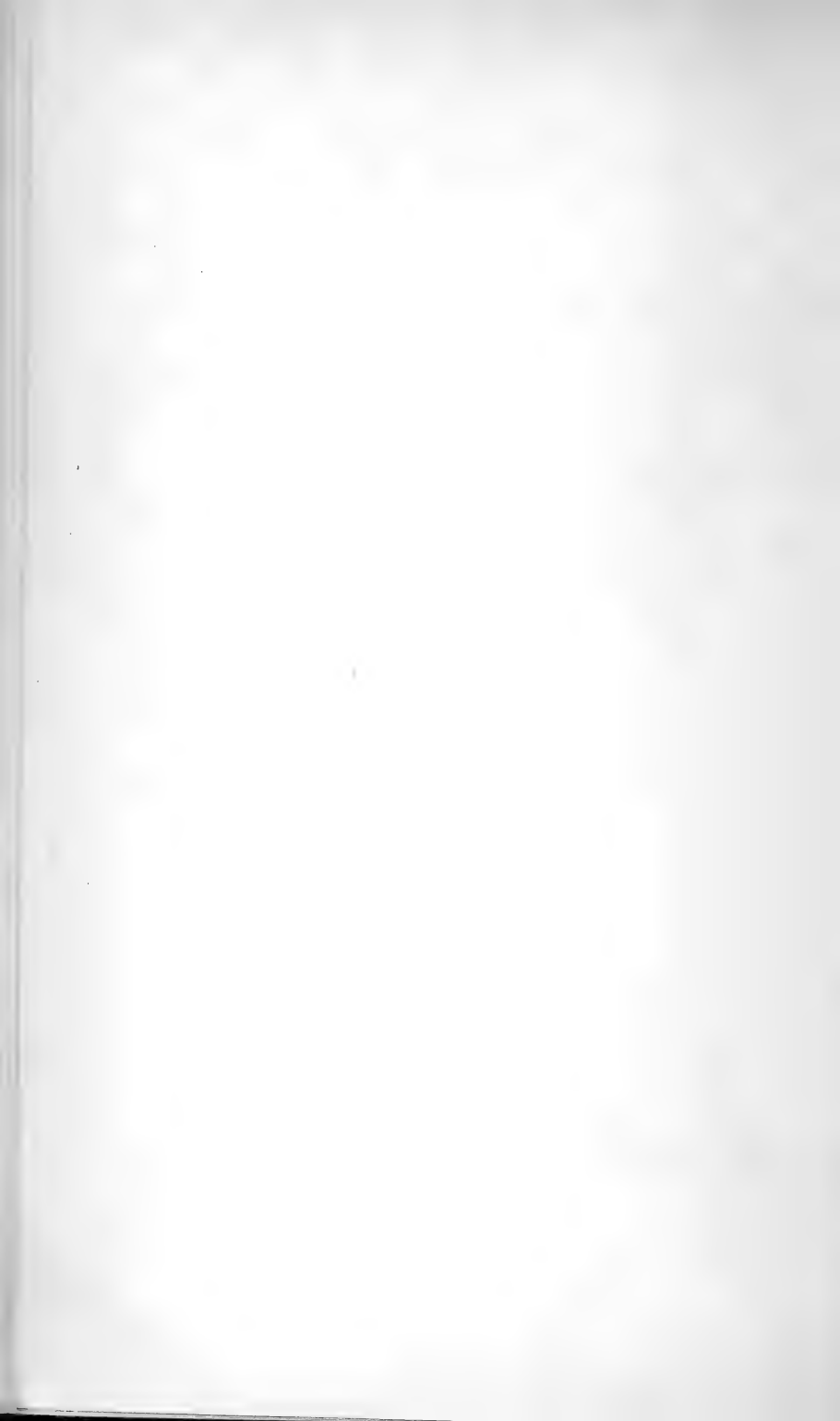


Fig. 6.

H. L. J., del.



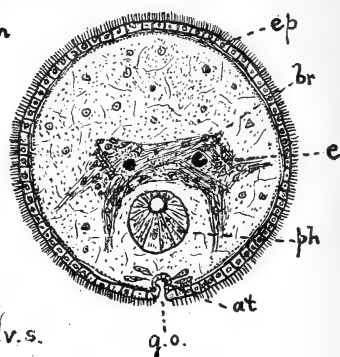
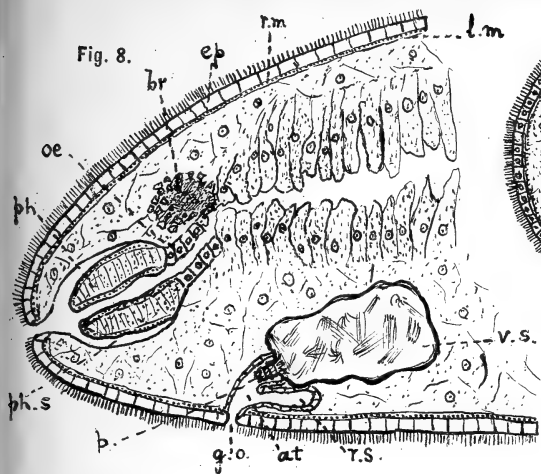


Fig. 9.

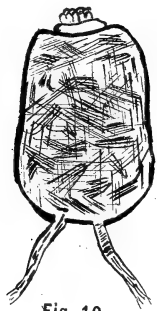
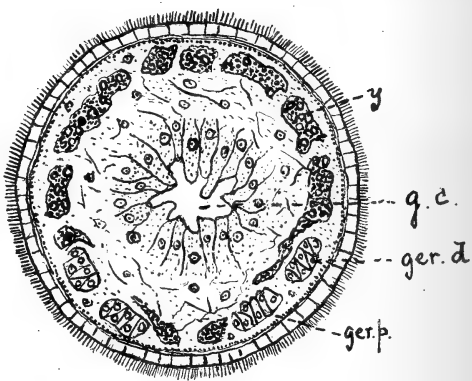


Fig. 10.



Fig. 11.

Fig. 12.

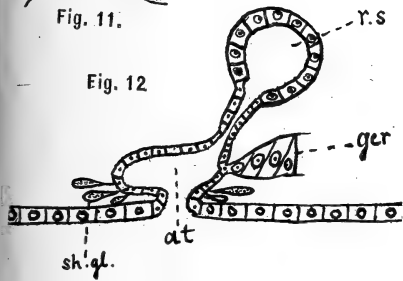
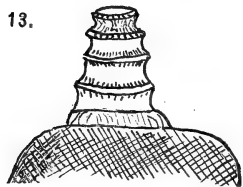


Fig. 13.



H. L. J., del.



Fig. 1.

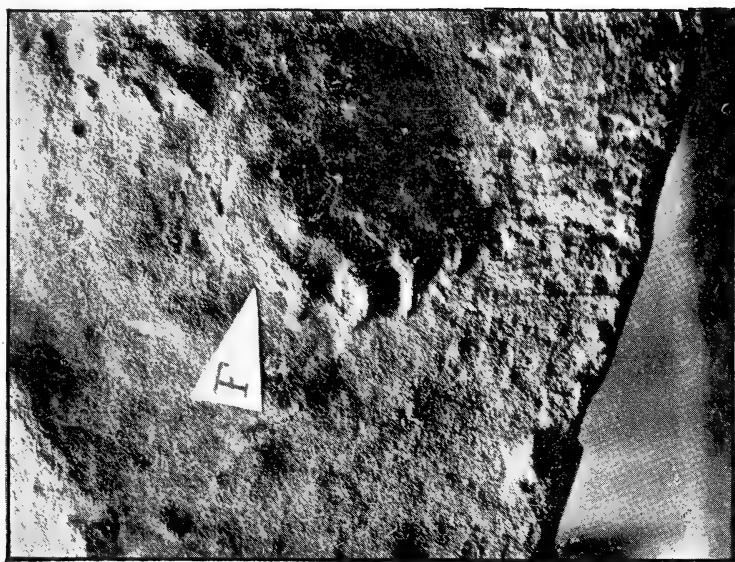
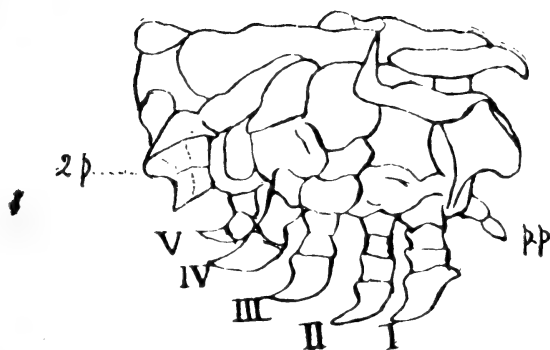


Fig. 2.



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900 66



